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WEEKLY 5 October 2024

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New Scientist Live

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NS Live

Our accidental universe

Hear Chris Lintott explain how astronomers stumble across their discoveries on 12 October at New Scientist Live, online or in person at London's ExCeL Centre. From the rich diversity of worlds in our solar system to the edge of the observable universe, he will reveal why what we know about the cosmos is usually the result of happenstance.

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Tour

The science of biodiversity: Costa Rica

Costa Rica covers just 0.03 per cent of the planet, but is one of the most species-dense countries in the world. Accompanied by our intrepid local tour leader, you will delve deep into the science behind biodiversity, visiting cloud forests, wetlands, primary rainforests, volcanic zones and marine reserves. This 13-day tour starts on 6 November and costs £5699.

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Podcast

Weekly

The team hear that the Arctic is losing ice at an alarming rate, so much so that it is too late to save it by cutting emissions alone. They also learn that octopuses and fish have been found hunting together in packs, in an unexpected display of cooperation, and unpack the health concerns around microplastics. Plus, the world's oldest cheese has been identified in China – and it dates back 3500 years.

newscientist.com/nspod

JANA SCIGELOVA/ALAMY

Rare frogs Experience Costa Rica's biodiversity firsthand

NASA, ESA, CSA, STScI, J. LEE (STScI), T. WILLIAMS (OXFORD), PHANGS TEAM

Galaxy quest Exploring our cosmos is bound to result in surprises

Video

Hidden figures

Hundreds of ancient drawings have been discovered in the Peruvian desert with the help of artificial intelligence. Archaeologists have linked these creations to the people of the ancient Nazca culture, who started etching such images, called geoglyphs, into the ground around 2000 years ago. The AI calculated the probability that each square of ground contained a drawing.

youtube.com/newscientist

Newsletter

Fix the Planet

Environment reporter James Dinneen considers how power lines could be refrigerated to become ultra-efficient, helping distribute the gigawatts of clean electricity now coming online. Surprisingly, the solution may come from superconducting technology designed for nuclear fusion power plants.

newscientist.com/fix-the-planet

Newsletter

"The energy transition is here. We've just gotta plug it in"

Essential guide

From tremendous chains of galaxies to supermassive black holes, our universe is a place of grandeur and spectacle. Find out how we are probing the cosmos like never before in this 24th *Essential Guide*. Available to download in the *New Scientist* app or to purchase in print from our shop.

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* We've changed Adam's name to help keep him safe. Photo: Jonathan Hyams / Save the Children.

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A note from the editor

New Scientist Live is back

Join us for a mind-blowing weekend of discovery and excitement

PREPARATIONS are now under way for our annual festival of science and ideas, New Scientist Live, which takes place in London in just one week's time.

The show opens on Saturday 12 October for two days packed with talks, hands-on activities and demonstrations, with something for everyone regardless of your age or interests. Explore the exhibition space, where some of our most popular interactive exhibits are back this year, including the hospital of the future – where you can try out surgical robots and virtual reality at the cutting edge of medicine – as well as the adrenaline-filled virtual rollercoaster ride. There are also brand-new experiences, involving ocean beasts, dinosaurs and more.

We have some amazing speakers joining us this year, including Alice Roberts, Turi King, Robin Dunbar and our own columnist David Robson. Across the four main stages – Mind and Body, Universe, Our Planet and Future – you can hear talks about everything from forensics and supermassive black holes to the secrets of gravity and how to eat for better brain health.

Our Engage Stage will also be bigger and better than ever. Here, you can spot some familiar *New Scientist* faces, including a live version of our Dead Planets Society podcast with hosts Leah Crane and Chelsea Whyte, plus culture editor Alison Flood hosting a sci-fi showdown that will answer the important question of what the best science fiction novel of all time is.

I am excited to be hosting a stage on Monday, our dedicated schools' day, where we open the doors to the next generation of scientists. The dedicated speaker line-up includes Suzie Imber and Dallas Campbell with live demonstrations, as well as Stefan Gates's highly explosive show!

As usual, we will have an exclusive area and other perks for subscribers, but everyone is welcome – and if you can't make it in person, you can also join via our live stream. I do hope to see you there.

Catherine de Lange

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© 2024 New Scientist Ltd, England. New Scientist is published weekly by New Scientist Ltd. ISSN 0262 4079. New Scientist (Online) ISSN 2059 5387. Registered at the Post Office as a newspaper and printed in England by Warners Midlands Plc

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News

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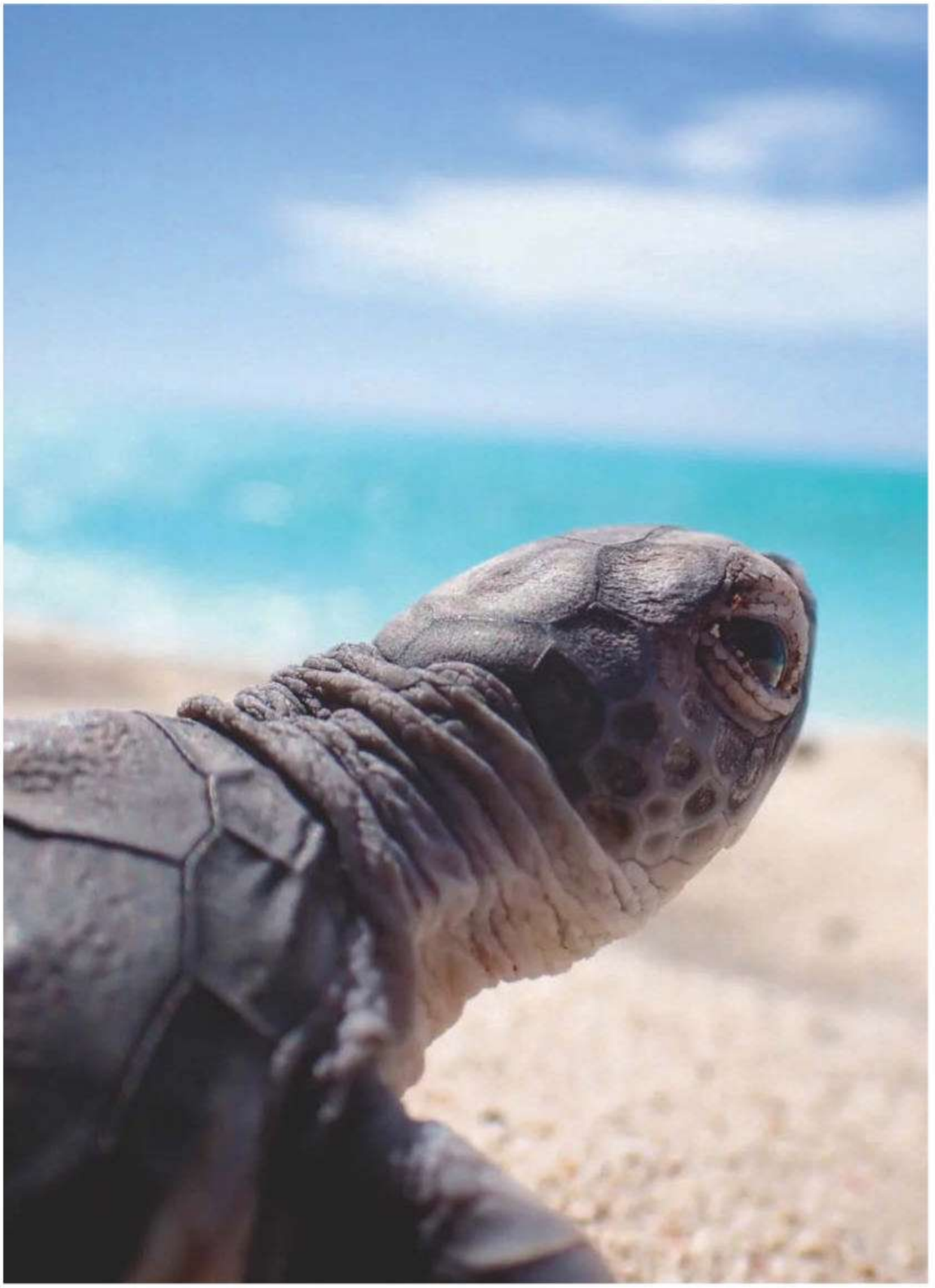


DAVID DOR/UNIVERSITY OF NEW SOUTH WALES

Zoology

The first of many epic journeys

We now know how baby green turtles (*Chelonia mydas*) swim upwards through sand after they hatch. Researchers attached tiny accelerometer backpacks (shown below) to turtles just after they emerged from eggs in the nest, buried below 4500 cubic centimetres of sand, but before they had dug their way out to reach the surface (left).

The hatchlings spent 67 per cent of their time vertical, as if swimming upwards, moving through the sand in minute-long bursts of activity. The journey took them between one and four days, and as they neared the surface, they started to move only at night, which is when they emerge (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2024.1702).

Analysis Quantum error correction

Useful quantum computers are getting closer

Google, Microsoft and others have taken big steps towards error-free devices, hinting that quantum computers that solve real problems aren't far away, says **Alex Wilkins**

DESPITE all the hype around quantum computers, they are still far too error-prone to be of real use. But recent experiments show that this may not always be the case, boosting the credibility of claims from companies like Google and IBM that we might get useful quantum computers as soon as 2029. These latest experiments represent key milestones and signal that we are entering a new age, say researchers.

"Suddenly, really useful devices seem tantalisingly close, in a way that they never have done before," says Jamie Vicary at the University of Cambridge.

For much of the past decade, quantum computing companies were focused on building ever larger machines, steadily increasing the number of quantum bits, or qubits, in their systems. Qubits are units of quantum information, made using physical systems like the spin of an electron or the orientation of a photon. But these qubits were too prone to errors to reliably run algorithms of real-world use.

Companies now appear to be shifting their attention towards building error-free qubits, called logical qubits. These are collections of physical qubits that together can reduce errors to a good enough level to run such algorithms. "It's marking a reset in the whole conversation around quantum computing and new benchmarks," says Vicary. "This is exciting because this is the time when quantum computers start to be useful."

In August, researchers at Google published a paper showing that as you build logical qubits by adding more physical qubits to a computer, the errors won't snowball and become unmanageable – they will instead cross a threshold where, in principle, they will shrink as the system gets larger. This works by spreading information across a group of qubits, so if an error occurs in one, it won't affect the overall computation.

"Ideally, you want to scale up while at the same time further reducing the error rates, improving the quality of your qubits," says Dan Browne at University College London. "Trying to do all of those things at once is very difficult, but what makes me optimistic is this Google experiment is an example of them doing exactly that."

"Suddenly, really useful devices seem tantalisingly close, in a way that they never have done before"

However Google's work didn't involve performing computations on the qubits – instead, the researchers showed that these qubits can act as memory, says Roberto Bondesan at Imperial College London.

A separate study published in September, from researchers at Microsoft and quantum computing start-up Quantinuum, shows a combination of error-corrected qubits and computation. The team set up different combinations of qubits to make four logical qubits, then performed basic logical operations on the system, for example where the value of a qubit is flipped from positive to negative. "They have fewer rounds of error correction, so their quantum memory is stable for less time, but they can also do some computation with it," says Bondesan.

The quantum computer in Microsoft's study uses a different hardware design to Google's, opting for a series of magnetically trapped charged particles instead of superconducting pieces of wire. This allows it to utilise an error-correction technique called a tesseract code, where qubits are arranged in a complex geometry known as a four-dimensional hypercube. "In principle, they can host more logical qubits, with fewer physical qubits," says Bondesan. "In this sense, it's more efficient."

Other researchers have shown error correction working in more unusual quantum computers. Benjamin Brock at Yale University and his colleagues tested a form of error correction called bosonic codes, which spreads out errors over vibrations in quantum computers. Instead of qubits, this system uses "qudits", which can take more values than just 1 and 0 and are theoretically more powerful. Meanwhile, researchers at Amazon's quantum computing team demonstrated another kind of bosonic code called category qubits, which, like Google's work, could reduce errors as systems get larger.

A display model of IBM's Q System One quantum computer

MISHA FRIEDMAN/GETTY IMAGES

Roadblocks ahead

"The Google and Microsoft approaches are really following more mainstream qubit-based quantum computing, whereas the introduction of bosonic codes in the Yale and the Amazon experiments are more novel and exploratory, but also very, very exciting," says Browne.

Seeing error correction work over so many different designs and experiments is a sign that previous theoretical results could work for real-world systems, says Browne. "There were lots of nice theoretical ideas about fault-tolerant quantum computing and error correction, but none of them had been demonstrated, or [they were demonstrated] in a very limited way or special case," says Browne. "That's really changed a lot in the last couple of years. There have been a lot of key milestones reached, demonstrating one by one different aspects of fault-tolerant quantum computing."

However, the rate of progress may yet falter and full fault-tolerant systems might still be a long way off, dashing the hopes raised by Google and IBM's optimistic timetables. "I would be surprised if we see things moving at a very consistent rate. I think there will be roadblocks," says Browne. "Each of these platforms is going to expand as far as they can until they hit the next roadblock. It's a little bit hard to predict where those roadblocks will be." ▮

Environment

Day flights are better for the climate

Aircraft contrails seem to have a net cooling effect in the daytime because they reflect sunlight

Madeleine Cuff

FLYING during the day rather than at night could be a swift way to limit the climate impact of a holiday because vapour trails produced by aircraft seem to cool the planet during the daytime.

Soot particles emitted by jet engines can trigger the formation of ice crystals, causing a condensation trail that may last for hours. These persistent contrails, as they are known, help to reflect solar radiation back to space, which has a cooling effect. But they also block heat from escaping from below, causing warming.

Previous studies have found that, overall, contrails have a net warming impact on Earth's climate that is potentially greater than the warming caused by carbon emissions from jet fuel. But the effect of individual contrails isn't as well understood.

So Irene Ortiz at Carlos III University of Madrid, Spain, and her colleagues set out to determine the net impact of individual contrails over two one-week periods in January in 2023 and 2024. The team used artificial intelligence to identify and analyse the net warming effect of 700,000 contrails from satellite imagery covering Europe, North Africa and surrounding oceans.

Researchers already knew that contrails that form during the night trap heat, but don't reflect any solar radiation, so they have a warming impact. By comparison, daytime contrails both trap heat and reflect sunlight, giving them a lower warming impact.

Contrails that form in the day can have a cooling effect on the planet

DAN KITWOOD/GETTY IMAGES

The team's conclusions go a step further, suggesting that most daytime contrails have a net cooling effect. Most of those seen in the study – 62 per cent – formed at night, which is why they found that the net effect of all contrails is a warming one, says Ortiz. However, the study only looked at the northern hemisphere in winter, when nights are longer (arXiv, doi.org/nj2r).

So, is flying during the day a better choice for the climate? Potentially yes, says Edward Gryspeerdt at Imperial College London. "Flying during the day, the contrails that you will generate will be less warming."

Switching to day flights wouldn't eliminate the climate impact of flying, says Nicolas Bellouin at Sorbonne University in France. "It doesn't mean that the overall impact of your flight will be a cooling of climate, of course, because you have carbon dioxide emissions that exert their own warming." But for flights on the same route, you are more likely to minimise the climate impact if you fly during the day, he says.

However, the climate benefit also depends on how long the contrails last. The average contrail lingers for 2.5 to 3.5 hours, but some can last 14 hours or more. So a contrail that forms in the later part of the day and lasts into the night can have a net warming effect.

A more promising solution might be re-routing jets to avoid leaving persistent contrails. They form when a plane passes through very humid, or supersaturated, air. Pilots could steer aircraft above or below supersaturated regions to prevent this happening. ▮

Health

New picture of how our immune system changes as we age

A MAP of the immune system has revealed how cells that are key to fighting off infections and certain medical conditions change with age. This could help improve vaccines and treatments for age-related diseases, such as cancer and rheumatoid arthritis.

Our immune system declines with age, but we lack a detailed picture of how its cells change across our lives, says Claire Gustafson at the Allen Institute in Seattle, Washington.

So, Gustafson and her colleagues have analysed genetic molecules called RNAs, some of which encode proteins vital to the immune system, in more than 13 million immune cells. These were collected via blood samples from 49 people aged 25 to 35 and 47 people aged 55 to 65.

The researchers found that the number of copies of RNA molecules inside T-cells – immune cells that target pathogens and cancer – differed the most with age.

To explore these changes across a wider age span, the researchers also analysed RNAs in T-cells collected from a separate group of 234 people, aged 40 to 90. This revealed that a subset of more than 100 RNAs increased gradually from age 40 to 65, before plateauing.

But from age 65 to 90, the number of a different group of RNAs rapidly dropped, marking a distinct phase of immune system ageing (bioRxiv, doi.org/g35h44).

These changes probably influence how effectively T-cells kill rogue cells and avoid harming healthy ones, which could explain why cancer and autoimmune conditions such as rheumatoid arthritis become more common as we age, says Donald Palmer at the Royal Veterinary College in London.

"Understanding immune system changes could lead to vaccines tailored to people of different ages"

A better understanding of such changes could help us develop vaccines that are tailored to people of different ages, says Palmer.

It could also improve cancer therapies for older people who receive genetically engineered T-cells, says Gustafson. ▮

Carissa Wong

Health

Tumours targeted by a precision radioactive ion beam

Alex Wilkins

A MORE accurate way to destroy tumours using beams of radioactive particles could help target hard-to-treat cancers near organs.

Most radiotherapy uses beams of X-rays to destroy cancerous cells, but this can damage healthy tissue in the beam's path. Newer methods that use beams of particles, such as proton therapy, can deliver most of their radiation in an extremely small space deep inside the body. However, it is hard to precisely direct where this peak radiation dose is absorbed, which can still risk damaging nearby organs.

Now, Marco Durante at the Technical University of Darmstadt in Germany and his colleagues have demonstrated a particle beam, using radioactive carbon ions, that can be directed more precisely.

When these ions enter the body, they decay and produce positrons, the antimatter counterpart of electrons. The positrons then collide with nearby electrons, and these annihilate each other and emit gamma rays, which can be used to locate the exact point at which the beam is depositing its radiation.

"You can adjust the position of the beam and you can make sure that you are not shooting in the wrong position," says Durante

He and his team used a beam of radioactive carbon isotopes on tumours next to the spinal cords of 32 mice and used a PET scan, which detects gamma rays, to ensure the beam was on target.

Mice that received a low dose of the beam therapy had slower tumour growth than mice that didn't get treated. And in mice that received a higher dose, the tumours stopped growing completely, and no damage to their spinal cords was detected (arXiv, doi.org/nj6d).

"It's incredibly exciting," says Richard Amos at University College London, but we don't yet know if it will work in people. ▮

Earth science

How 'river piracy' may have made Mount Everest even taller

James Dinneen

AN ANCIENT act of "river piracy" might be partly responsible for Mount Everest's soaring height.

At 8849 metres above sea level, Mount Everest – also called Chomolungma or Sagarmāthā – is the world's highest peak. Most of this stature is due to the tectonic uplift that formed the rest of the Himalayas. But Everest is an outlier, jutting above neighbouring giants by some 250 metres.

Matthew Fox at University College London and his colleagues considered how the distinctive pattern of rivers flowing around the mountain may have contributed to this height anomaly by eroding away the rock that lies close to the flanks of Mount Everest.

"The thick rocks that make up the Himalayas are floating on the underlying mantle," says Fox. When rivers cut through the landscape, eroding rock and forming a deep gorge, the mantle responds by rebounding upwards. This means that the erosion process, despite removing rock, actually causes the land surface to rise.

Fox and his colleagues focused on the Arun river, which flows north from Everest, before circling back to the south and passing through the narrow but deep Arun gorge. A long-standing debate is whether the river took this circuitous route before the rise of the Himalayas or whether it changed course after the mountains rose.

89,000
years ago, erosion by a river may have started lifting Everest

One possibility is that the river initially drained a relatively small area, but as the mountains formed there was a "drainage piracy" event that saw it capture the waters draining from a much larger area.

The researchers modelled scenarios of how such a capture event may have played out. If it occurred, it would have led to a dramatic increase in the volume of water flowing down the Arun river. This, in turn, would have given the river a greater capacity to erode the landscape and create the Arun gorge, which would have affected patterns of elevation in the region and added to Everest's height.

The scenario that gave the closest match to today's pattern of river elevation involved a capture event about 89,000 years ago. At that point, "the Arun river continued to erode backwards and stole the upstream drainage area", says Fox. A final nudge may have come from extreme precipitation or a landslide pushing the river to change course.

The researchers estimated how much extra rock would have been eroded by the Arun river after such an event. They say it would correspond to a rebound effect that adds 0.16 to 0.53 millimetres per year to Everest's elevation, equivalent to a 15 to 50 metre rise since the capture (*Nature Geoscience*, DOI: 10.1038/s41561-024-01535-w).

The principle that river erosion can raise elevation is well known, says Mike Searle at the University of Oxford. However, he is sceptical that these estimates based on modelling tell the full story. "The question here is whether the river is causing the uplift or not. To me, it's not. It's the tectonics," he says.

Sylvain Barbot at the University of Southern California points out that tectonic activity may have triggered the drainage piracy event itself, making it the ultimate source of Everest's majesty. ▮

Everest (lit by the sunset) is the highest mountain above sea level on Earth

TOM GRUNDY/ALAMY

Technology

AI photo tweaks can alter memories

People misremember more details if images are edited to change what really happened

Matthew Sparkes

HUMAN memories can be distorted by photos and videos edited by artificial intelligence, raising concerns over what might happen if such manipulation becomes an automatic feature of smartphones.

Samantha Chan at the Massachusetts Institute of Technology and her colleagues recruited 200 people, showing them the same collection of 24 photos. Then, participants did an unconnected 2-minute task.

After this, the researchers split the people into four equal groups and showed them either the original photographs once more, AI-edited versions of them, AI-generated video created from the original photos or AI-generated video created from AI-edited versions of the photos. The changes made by AI included the addition or removal of people or objects, altering the ethnicity or gender of people and swapping weather conditions.

Next, all participants completed a memory test that comprised 24 questions about the original images. Some 20 per cent of the group who saw the original images twice remembered details incorrectly, showing human recall is fallible anyway.

MIT MEDIA LAB

A pair of images used to assess people's memory, the right-hand one altered

But in all three of the other groups, the rate of false memories was even higher, with the worst scores being from the group that saw AI-generated video of AI-edited photos. These participants had a false memory rate of around 40 per cent (arXiv, doi.org/nj2k).

Smartphones from Apple, Google and Samsung now have AI tools to edit photos, allowing users to remove unwanted people or objects or combine elements from multiple photos into one, and generative AI models such as OpenAI's Sora are increasingly capable of animating static images into realistic video.

Chan says it is ultimately down to personal choice whether people edit their photos and videos, but it is important this choice remains and people are aware of the repercussions if they do editing.

"In the future, it might be automatic," she says. "I think the worst part here, that we need to be aware or concerned about, is when the user isn't aware of it. We definitely have to be aware and work together with these companies, or have a way to mitigate these effects. Maybe have sort of a structure where users can still control and say 'I want to remember this as it was', or at least have a tag that says 'this was a doctored photo'."

Philip Beaman at the University of Reading, UK, says false memories could be implanted either on a personal level with edited photo albums, or more widely with images released in mainstream or social media. However, in all cases, there is a limit to how much memories can be distorted before people question them.

"There is absolutely nothing new here, psychologically," says Beaman. "The fact that you can implant false memories using edited images is not a surprise. What exacerbates it in this current time, which is unique I think, is that it's quick and easy to do the AI. Anybody can do it." ▮

New Scientist Live

AI needs you

Hear Verity Harding reveal what past tech revolutions tell us about AI's future on 12 October **newscientist.com/nslmag**

Marine biology

Octopuses and fish team up to catch prey

DESPITE generally being solitary animals, octopuses work with fish to find prey and punch team members that aren't helping.

Day octopuses (*Octopus cyanea*) are common in the Indo-Pacific and hunt by wrapping themselves around objects like rocks, making a bag with the membrane between their tentacles to trap small animals.

Hunting groups consisting of a single day octopus and a number of fish were described in the 1990s, says Eduardo Sampaio at the Max Planck Institute of Animal Behaviour in Germany, but it was thought the fish simply follow the octopus to try to grab any prey that escape.

During dives in the Red Sea, Sampaio and his team recorded 13 group hunts, noting a team effort, including participating fish trying to attract the attention of an octopus.

"Not only are the fish following the octopus around, but the octopus is definitely following the fish around as well," says Sampaio.

EDUARDO SAMPAIO/SIMON GINGINS

A day octopus hunting with a blue goatfish, while a blacktip grouper lurks at top centre

If a fish that has seen prey hiding beyond its reach is ignored, it swims back and forth to get the octopus's attention, says Sampaio. What's more, the octopus will punch away lingering fish that aren't helping but are looking for a free lunch (*Nature Ecology & Evolution*, doi.org/nj2m).

Blue goatfish (*Parupeneus cyclostomus*) were the best hunting partners, actively seeking prey and leading the octopus to it. Blacktip groupers (*Epinephelus fasciatus*) were the least likely to find prey. Octopuses seem to know this and were seen punching blue goatfish three times, but blacktips 27 times. ▮

Michael Le Page

Environment

Jet stream linked to fires and plague

The historical impacts on Europe of shifts in these high-level winds have been revealed by tree ring data, highlighting risks in a warming world, finds **Madeleine Cuff**

EXTREME weather caused by the movement of a jet stream seems to have brought summers of fires, failed harvests and rampant disease across Europe over the past 700 years. That is the conclusion of an analysis of tree ring data, which also provides worrying clues for what the future holds under a changing climate.

Jet streams are bands of fast-moving winds high in the atmosphere, which blow around the world from west to east. The northern hemisphere polar jet influences weather conditions over Europe by dictating where events such as storms and heatwaves strike.

Observational records using satellite data only began in the past 40 years, and non-satellite data goes back to the late 1940s, so scientists have struggled to piece together how the influence of this jet stream on European weather has changed over longer periods.

To find out, Valerie Trouet at the University of Arizona and her colleagues set out to extend this historical record by analysing tree ring data. They used samples taken in Scotland, the Alps and the Balkans to understand the position of the jet during European summers since 1300.

Trouet and her team analysed the wood to identify the weather conditions at various times and, by comparing the samples, the position of the northern polar jet stream. "Instead of 60 to 70 years of jet stream variability, we now have 700 years of jet stream variability, thanks to the tree ring data that we used," she says.

The researchers then cross-referenced the information with other historical records of grape harvests, wildfires, grain prices and mortality rates, to understand the "cascade" impacts of this jet stream's shifting position during summer.

700
Years of jet stream variability revealed by tree ring analysis

"Even under natural conditions, the jet stream has an important role in creating really extreme weather"

When this jet stream is in a more northerly position in this season, cooler and wetter weather tends to prevail over the British Isles, while hotter, drier conditions linger over southern and eastern Europe (*Nature*, doi.org/njt6).

Historically, this has brought more wildfires to eastern Europe and lower agricultural yields, leading to higher grain prices, they found. In the British Isles, by contrast, cold, wet summer conditions probably meant people spent more time inside and diseases such as plague spread more easily, leading to higher levels of mortality.

Conversely, when the polar jet stream was in a southerly position at this time of year, wet weather ruined grape harvests in the Balkans and prompted the spread of diseases through much of continental Europe.

"We understand the link between these societal factors and weather, we know that cold and wet weather is bad for your grape harvest, we know it's bad for diseases, and so now we show that the jet stream controls that kind of weather over Europe," says Trouet.

Tim Woollings at the University of Oxford says the study could be really valuable, particularly as satellite records for jet streams are relatively short.

"In terms of the direct measurements of the atmosphere, we can only go back so far," says Woollings. "That makes it really hard to unpick what's going on, because we have such a short observational record. So having these studies piece together how the jet behaved is really valuable."

"The challenge for us now is to work out how to use this information practically to test and improve our models and our predictions," he adds.

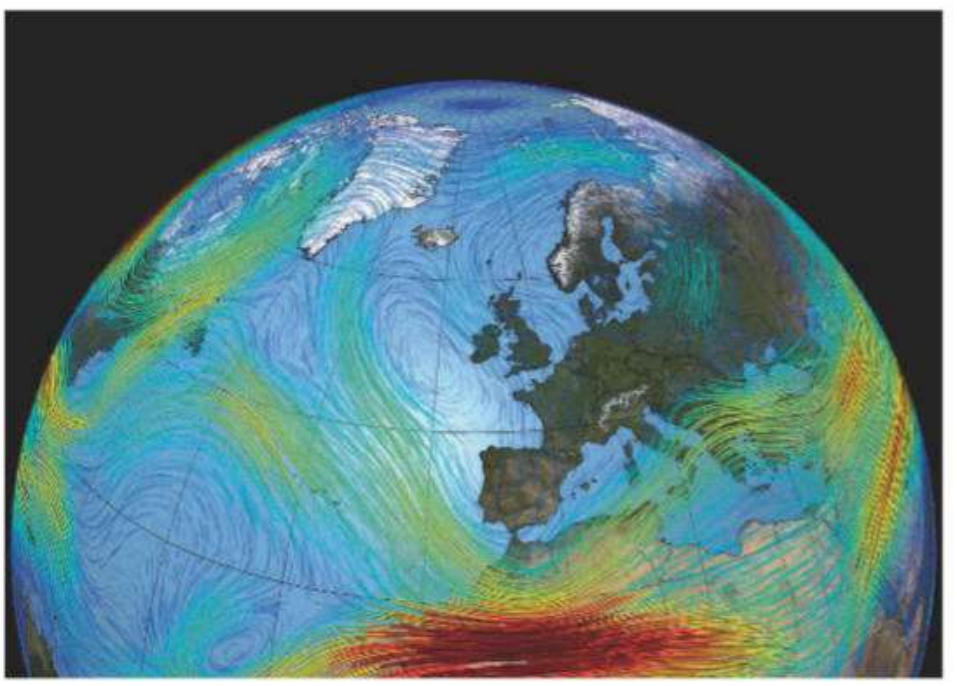
Advancing on the poles

Climate scientists believe jet streams are shifting polewards as the climate warms, as increasing heat in the tropics pushes the storms that help fuel the jets further from the equator.

A jet stream positioned further north than normal over Europe during summer has the most extreme impacts, the paper says, increasing the risk of hotter, drier conditions for most of the continent. Climate change will amplify the impacts of these events, says Trouet, increasing, for example, the risk of disastrous wildfires, the spread of disease and food scarcity.

"Even under natural conditions, the jet stream has a very important role in creating really extreme weather conditions and extreme societal conditions. Now if you add anthropogenic climate change to that natural variability, it amplifies the pattern," she says. ▮

Jet streams are strong winds that blow far above Earth's surface



NASA'S SCIENTIFIC VISUALIZATION STUDIO

New Scientist Live

Have we been predicting the climate all wrong?
Hear David Stainforth argue for a different approach on 13 October **newscientist.com/nslmag**

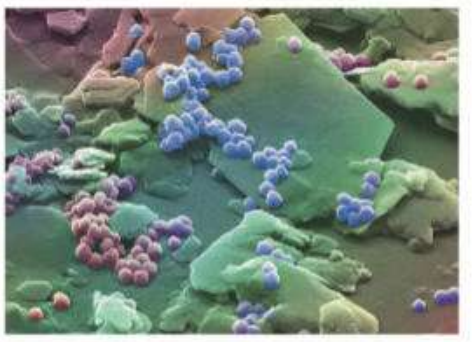
How much should we worry about microplastics harming us?

Many studies have found tiny bits of plastic throughout the human body. But whether they are bad for our health is still to be worked out, says **Grace Wade**

MICROPLASTICS have been found in parts of the body ranging from our livers to our lungs. They have even shown up in human breast milk. Last month, they turned up in the olfactory bulbs of people, a brain structure crucial for smell.

These small plastic fragments – less than 5 millimetres in size – form when larger pieces of plastic, such as those found in car tyres or food packaging, are broken down. They then make their way into our bodies through food, water and the air we breathe. Manufacturers also add them to certain goods, such as exfoliating skincare products.

But it isn't clear what, if any, impact microplastics have on our bodies. So far, the most compelling evidence they can harm our health comes from a study published earlier this year, which detected such fragments in plaques removed from the arteries of 150 out of 257 adults. These are a buildup of cholesterol, fats and blood cells that can reduce blood flow. The people with the artery plaques containing microplastics were four times as likely to have died or had a heart attack or stroke than the other people 34 months later.



STEVE GSCHMEISSNER/SPL

Microplastic beads found in a cosmetic facial scrub

The finding doesn't prove microplastics cause heart attacks or strokes – it only establishes a correlation. It is possible other factors could underlie the association. For example, people whose plaques contained microplastics may be exposed to greater amounts of air pollution, which can contain the fragments. And air pollution is a known risk factor for heart disease.

"Microplastics have now been found in the olfactory bulbs in the brains of people"

Most of the clues about the potential health harms of microplastics come from animal research. In 2022, Tracey Woodruff at the University of California, San Francisco, and her colleagues reviewed data from 24 studies involving rodents. They found microplastics had detrimental effects on the digestive, reproductive and respiratory systems of the animals. Woodruff says this indicates microplastics may raise the risk of conditions like colon cancer or infertility.

However, a 2022 report from the World Health Organization points out that most animal studies use concentrations of microplastics much higher than those people are typically exposed to, making it hard to translate the findings to humans.

Adding to the challenge is the fact that microplastics come in a range of shapes, sizes and materials, each of which may have distinct health effects. Richard Thompson at the University of Plymouth, UK, and his colleagues have now found that more than half of studies assessing the toxicity of microplastics looked at just two types of common plastics: polystyrene or polyethylene. Most studies also use spherical plastic particles even though most microplastics are irregular shapes (*Science*, doi.org/njs9).

All of these limitations make it impossible, at least for now, to know if microplastics are detrimental to human health. Yet that doesn't mean we should assume they are harmless, especially as they accumulate. "We know that these particles are going to be incredibly difficult to remove," says Thompson. He recommends we take a precautionary approach: reducing plastic production and preventing them from entering the environment. ▮

Archaeology

World's oldest cheese found on Chinese mummies

A MYSTERIOUS white substance found on Bronze Age mummies in China is the world's oldest cheese.

The food remnants were found about two decades ago, smeared on the heads and necks of mummies found in the Xiaohe cemetery in Xinjiang province. These bodies date from around 3500 years ago.

It had been suspected that the substance may have had a fermented dairy origin, but only now have molecular tools been able to confirm this. Based on the presence of yeast, lactic acid bacteria and proteins from ruminant milk, Qiaomei Fu at the Chinese Academy of Sciences in Beijing and her colleagues have identified the substance as a kind of kefir cheese.

Kefir is a traditional drink made by fermenting milk using kefir grains, which are pellets of microbial cultures, like a sourdough starter. Fu says the substance was no longer immediately recognisable as kefir cheese. "Due to their age, these pale-yellow cheese samples smelled of nothing and were powdery to touch and a little crumbly," she says.

While there has been archaeological evidence from pottery of cheese-making from as long as 7000 years ago, no one has ever found such ancient cheese.

The team spotted goat and cow DNA in the samples, but it appears that the milk from each of these animals was kept separate – unlike the mixed cheeses in many Middle Eastern cheese-making traditions (*Cell*, doi.org/njz2). This may have been because goat's milk is lower in lactose and so less likely to cause gut problems when consumed.

Fu and her colleagues also recovered the DNA of *Lactobacillus kefiranofaciens* bacteria from the dairy samples, which they compared with the genomes of modern strains used to make kefir.

The modern strains have evolved in line with the preferences of cheese consumers, says Fu. For example, strains that cause less of an immune response in the human intestine have been selected. ▮

James Woodford

LI WENYING/XINJIANG CULTURAL RELICS AND ARCHAEOLOGY INSTITUTE

A mummy from Xiaohe cemetery in China that had dairy remains near its neck

Archaeology

Hundreds more Nazca drawings discovered in Peruvian desert

Jeremy Hsu

A HUGE number of ancient drawings depicting decapitated human heads and domesticated llamas have been discovered in the Peruvian desert with the help of artificial intelligence.

Archaeologists have previously linked these creations to the people of the Nazca culture, who started etching such images, called geoglyphs, into the ground around 2000 years ago.

303

Number of giant desert drawings found with the help of an AI

These geoglyphs are smaller and older than the Nazca lines and other figures that had already been found, which portray huge geometric shapes stretching several kilometres or wild animals about 90 metres long on average.

The newly discovered images typically depict humanoid figures and domesticated animals around 9 metres long. Some even hint at human sacrifice, portraying decapitated heads and killer whales armed with blades.

"On some pottery from the Nazca period, there are scenes depicting orcas with knives cutting off human heads," says Masato Sakai at Yamagata University in Japan. "So we can position orcas as beings that carry out human sacrifice."

Sakai and his colleagues found the smaller geoglyphs by training an AI model to look for them in aerial photos. The high-resolution photos covered an area about 10 times as large as Manhattan, which encompassed the desert plateau called the Nazca Pampa and its surroundings. It included the UNESCO World Heritage Site for the Nazca lines. The AI then produced a grid-based map that categorised the probability of each grid square containing geoglyphs.

The researchers still spent more than 2600 hours manually inspecting the highest-probability photos and doing field inspections. But they estimate the AI helped speed up the screening process by a factor of 50 by eliminating 98 per cent of low-probability aerial imagery and providing probabilities for the remaining 2 per cent, says team member Marcus Freitag at IBM Research in New York.

The researchers followed up on the AI suggestions and discovered a total of 303 figurative geoglyphs during field surveys in 2022 and 2023. Of these figures, 178 geoglyphs were individually identified by the AI. Another 66 weren't directly pinpointed, but the researchers found them in a group of potential geoglyphs the AI had highlighted (*PNAS*, doi.org/njvg).

"The AI-based analysis of remote sensing data is a major step forward, since a complete map of the geoglyphs of the Nazca region is still not available," says Karsten Lambers at Leiden University in the Netherlands. But he also says that, like humans, this technology is more likely to find the more visible geoglyphs than any harder-to-see ones.

Nearly 1000 AI-identified candidates are still awaiting inspection during future field surveys, says Sakai.

The AI screening offers hope for discovering geoglyphs elsewhere in the world, says David Beresford-Jones at the University of Cambridge. Speed is crucial because many geoglyphs "lie on the cusp of erasure through agricultural expansion, urban development and wind-power generation", he says. ▮

A 22-metre-long drawing, potentially of a killer whale with a knife

MASATO SAKAI

New Scientist Live

How our biology shaped world history

See Lewis Dartnell chart the course humanity has taken on 13 October newscientist.com/nslmag

Technology

AIs get worse on simple questions as they get bigger

Chris Stokel-Walker

LARGE language models (LLMs), which power AI chatbots, seem to get less reliable at answering simple questions when they get bigger and learn from human feedback.

AI developers try to improve LLM performance in two main ways: scaling up – using more training data and computational power – and shaping up, or fine-tuning them in response to human feedback.

José Hernández-Orallo at the Polytechnic University of Valencia, Spain, and his colleagues examined the performance of LLMs as they scaled up and shaped up. They looked at OpenAI's GPT series of chatbots, Meta's LLaMA AI models and BLOOM, developed by a group of researchers called BigScience.

The researchers tested the AIs by posing five types of task: arithmetic problems, solving anagrams, geographical questions, scientific challenges and pulling out information from disorganised lists.

They found that scaling up and shaping up can make LLMs better at answering tricky questions, such as rearranging the anagram "yoiirtsrphaepmdhray" into "hyperparathyroidism". But this isn't matched by improvement on basic questions, such as "what do you get when you add together 24427 and 7120", which the LLMs continue to get wrong (*Nature*, doi.org/njtf).

While their performance on difficult questions got better, the likelihood that an AI system would avoid answering any one question – because it couldn't – dropped. As a result, the likelihood of an incorrect answer rose.

The results highlight the dangers of presenting AIs as omniscient, says Hernández-Orallo. "We have an overreliance on these systems," he says. "We rely on and we trust them more than we should."

OpenAI, Meta and BigScience didn't respond to a request for comment on the study. ▮

Environment

The greenest cooking oil?

Growing camellia plants for cooking oil could boost production and reduce environmental impacts

Michael Le Page

REPLACING some vegetable oil crops with camellia plants could boost cooking oil production while cutting greenhouse gas emissions, water use and pesticide use.

That is because camellia is a high-yielding shrub that can thrive in places where some other oil crops struggle. The properties of camellia oil, also known as tea seed oil, suggest it could also be one of the healthier oils, but it is currently little-known and hardly used outside China.

About a third of the world's farmland is used to grow vegetable oils. This area is expanding, contributing to deforestation, global warming and wildlife loss.

"It is a shocking figure," says Thomas Wanger at Westlake University in Hangzhou, China. He and his colleagues have looked at the six main vegetable oil crops – soya, palm, rapeseed, sunflower, peanut and olive – and estimated their impact in terms of greenhouse gas emissions, water use, land use and pesticides.

They say the production of oil from these six crops produces the equivalent of 1.2 gigatonnes of carbon dioxide per year, mainly from the use of fertilisers and deforestation. For comparison, total CO_2 emissions from the burning of fossil fuels were around 37 gigatonnes in 2023.

LONG YUANBIN/IMAGO/ALAMY

People drying camellia fruits in Songtao in Guizhou province, China

Next, the team explored how the environmental impact would change if some of these crops were replaced with *Camellia oleifera*, a relative of the tea plant (*Camellia sinensis*). Compared with other oil crops, *C. oleifera* has several advantages, says Wanger. It can yield up to 2.8 tonnes of oil per hectare, for instance, second only to palm oil. It can also thrive in comparatively poor soil and on steep slopes, he says.

Camellia oil also has desirable properties. Like olive oil, it consists mostly of oleic acid. Oils high in this acid appear to reduce the risk of heart disease when consumed in place of other oils and fats. It also has a higher smoke point than most other oils, meaning it can reach higher temperatures before starting to burn. This, along with its composition, should reduce the formation of harmful chemicals called polyaromatic hydrocarbons and aldehydes during cooking.

If camellia replaced other oil crops on 11 per cent of the land where those crops are currently grown, the same amount of vegetable oil could be produced while reducing greenhouse gas emissions by 14 per cent, water use by 5 per cent, land use by 7 per cent and pesticide use by 9 per cent in a conservative scenario, say the researchers (bioRxiv, doi.org/njtn).

These figures would be contingent on how camellia is grown, says Wanger. "The benefits depend strongly on where it is planted and to replace what."

Government action would probably be needed to encourage a camellia oil market, says Wanger. "The price currently is very high, and so I think the consumer might be a bit reluctant."

"The commercial reality is that new oil crops won't achieve a large market share unless production can compete in the market," says Chris Malins at alternative fuels consultancy Cerulogy. ▮

Archaeology

Cannibalised person on doomed Franklin expedition identified

HUMAN remains recovered from the British Royal Navy's doomed Franklin expedition have been identified as those of James Fitzjames using DNA and genealogical evidence. He has also been confirmed as the first known person to be cannibalised among the expedition members.

In 1845, an expedition led by John Franklin set out to find a navigable North-West Passage through the Arctic with 129 men aboard the ships HMS Terror and HMS Erebus. But in 1848, Fitzjames, captain of HMS Erebus, left a report in a stone cairn recording how the survivors had decided to abandon the ships. Later, the unidentified skeletal remains of many sailors were discovered in various locations across the Canadian Arctic.

Now, researchers have put a name to some of those remains. Douglas Stenton at the University of Waterloo in Canada and his colleagues identified Fitzjames by comparing the Y chromosome profiles from a tooth that was found on Canada's King William Island with cheek swabs taken from one of Fitzjames's descendants.

CC-BY-SA-4.0

James Fitzjames, captain of HMS Erebus, in 1845

The discovery also makes Fitzjames the first cannibalised person on the expedition to be identified (*Journal of Archaeological Science: Reports*, doi.org/njtd). Previous research had revealed cut marks on many of the recovered remains, with one lower jawbone – now revealed as belonging to Fitzjames – having multiple such marks.

This indicates that some of the last survivors who were trekking overland resorted to eating parts of Fitzjames's body and those of several other sailors. The finding "reveals the desperation of the Franklin sailors", says Treena Swanston at MacEwan University in Canada. ▮

Jeremy Hsu

Technology

How smart devices can learn your habits

Smart TVs and voice assistants can track your behaviour and habits at home in their own ways – and it isn't always easy to opt out, finds **Jeremy Hsu**

THE world's most popular smart TV models, and voice assistants like Amazon's Alexa and Google Assistant, really are tracking your activities when you least expect it – and they are learning from your habits and interests to do targeted advertising.

Smart TV manufacturers use frequent screenshots and audio clips in their automatic content recognition systems, designed to track viewed content for advertising purposes. Samsung TVs can take screenshots every 500 milliseconds and LG TVs upload 10-millisecond audio samples from viewed content. But researchers have now shown that this tracking by smart TVs occurs even when they are being used as external displays for a laptop or video game console.

"When a user connects their laptop via HDMI just to browse stuff on their laptop on a bigger screen by using the TV as a 'dumb' display, they are unsuspecting of their activity being screenshotted," says Yash Vekaria at the University of California, Davis. An LG spokesperson said the firm's system relies only on "audio watermark technology" and Samsung didn't respond to a request for comment.

Vekaria and his colleagues connected smart TVs from Samsung and LG to their own computer server that acted as a middleman to track network activity that could indicate what visual snapshots or audio data the TVs were uploading.

They found that the smart TVs didn't appear to upload any tracking data when streaming from Netflix or other third-party apps, mirroring YouTube content from a separate device or when sitting idle. But the smart TVs did upload data when showing broadcasts from the TV antenna or content from an HDMI-connected device (arXiv, doi.org/njzg).

The researchers also discovered country-specific differences when users streamed the free ad-supported TV channels provided by Samsung or LG platforms. Data was uploaded when the TV was operating in the US, but not the UK.

LG and Samsung documentation described such content tracking as an opt-in choice during the TV setup process. Customers can later opt out, but this requires them to change multiple options in the TV settings.

"This is the sort of privacy-intrusive technology that should require people to opt in to sharing their data with clear language explaining exactly what they're agreeing to," says Thorin Klosowski at the Electronic Frontier Foundation, a digital privacy non-profit based in California.

Listening in

Smart TVs aren't alone in tracking people's activities. By simulating fake people while interacting with popular smart voice assistants, such as Amazon's Alexa, Google Assistant and Apple's Siri, researchers have uncovered how each system learns users' personal preferences.

ANTHONY BROWN/ALAMY

To profile you, smart speakers and TVs can collate information about what you like

"I don't know that consumers have the intuition that when you're talking out loud, that also could potentially be used to profile you and then target you with ads," says David Choffnes at Northeastern University in Massachusetts.

Choffnes and his colleagues tested the three popular voice assistants on more than 24,000 voice queries and text-based web searches to simulate a variety of people, such as a "fashion persona" or "books and magazines persona" for Alexa users. They then used data disclosure requests to find out whether the voice assistants had accurately labelled these personas.

"This is the sort of privacy-intrusive technology that should require people to opt in to sharing their data"

Amazon's Alexa achieved 100 per cent accuracy. It labels consumer personas based on shopping and purchasing commands, but general questions don't result in profiling, says co-author Tina Khezresmaeilzadeh at the University of Southern California in Los Angeles.

"Similar to other Amazon services, we may use customers' interactions with Alexa to provide more relevant ads," says an Amazon representative. They also say customers can choose whether to receive interest-based ads by changing a single setting.

By comparison, Google Assistant delivered imperfect profiling. For example, it applied the "married" label with 70 per cent accuracy and identified users as having an advanced degree with 50 per cent accuracy. It also assigned initial profile labels for new user accounts prior to any voice interactions, says co-author Elaine Zhu at Northeastern University. A Google spokesperson said users can select categories used to show ads or turn off personalised ads.

Only Apple's Siri didn't appear to profile users based on voice interactions (arXiv, doi.org/njzh). An Apple representative says: "We clearly state on our website and privacy pages that 'Siri Data is not used to build a marketing profile, and is never sold to anyone.'"

Some firms are upgrading their voice assistants with generative AI to improve their understanding of human language. "If voice assistants improve, I'd guess more people will use them more often, possibly for more personal questions," says Klosowski. "And as those lines between our devices blur even more, it's ripe for user confusion about what data is kept private and what isn't." ▮

SHUTTERSTOCK/MEDIA_PHOTOS

Zoology

Axolotls seem to pause their biological clocks and stop ageing

Claire Ainsworth

EVER wished you could hit the pause button on ageing? At least one creature may do just that. Axolotls appear able to halt one of the hallmarks of the process, a finding that could shed new light on ageing and regeneration.

Axolotls (*Ambystoma mexicanum*) belong to the salamander group of amphibians, which have astonishing powers of regeneration, such as regrowing amputated limbs. They also seem to age very little, a feature called negligible senescence.

But we know little about how axolotls achieve negligible senescence, if they truly do. Even their cause of death is generally a mystery. "Basically, no one in the field knows what axolotls die of," says Maximina Yun at Dresden University of Technology in Germany.

To find out more, Yun and her colleagues studied a hallmark of ageing called DNA methylation. This is a factor influencing epigenetics, or how genes are switched on or off, and it involves chemical markers on DNA.

SHUTTERSTOCK/ARUNEE RODLOY

Axolotls apparently age very little and can regrow lost limbs

In mammals and frogs, the pattern of marks across the genome changes over time, and scientists have made statistical models, called epigenetic clocks, that correlate these changing patterns with chronological age.

But the team could only build an epigenetic clock for the first four years of the axolotl's lives, about a third of their average lifespan (bioRxiv, doi.org/njs6).

Thereafter, the clock stopped: the animals' methylation patterns appeared to remain stable. "This is remarkable as it suggests that, at least at epigenetic levels, axolotls may indeed exhibit negligible senescence," says Yun.

How epigenetic changes contribute to ageing isn't clear, but they are linked to the way in which cells acquire their specialised functions during development. Artificially undoing cell specialisation, a process called reprogramming, "rejuvenates" cells, resetting their epigenetic clocks and wiping their memory.

When axolotls regenerate an amputated limb, their cells also undo cell specialisation, but only part way. "They retain a very strong identity of what they were, where they are and they know what parts of the limb are missing," says Yun.

When the researchers looked at the methylation patterns in regenerated axolotl limbs, they found that these were epigenetically younger than the rest of the animal. "It's an example of natural rejuvenation," says Yun.

This raises the possibility that animals that can regenerate throughout life retain some kind of developmental flexibility that counteracts at least some ageing processes, says Yun. ▮

New Scientist Live

Why do we die?

See Venki Ramakrishnan transform our understanding of ageing on 12 October **newscientist.com/nslmag**

Extraterrestrial life

Hunt for alien transmissions draws a blank

A SEARCH for aliens communicating between planets in one of the most promising systems to look for life has come up empty.

Discovered in 2017, TRAPPIST-1 is a system of seven Earth-sized planets orbiting a red dwarf star much dimmer than our sun, about 40 light years away. The planets all orbit closer than Mercury does to our sun and pass in front of their star from our point of view. Three of the planets orbit in the star's habitable zone, where liquid water can exist, and they might be good locations to look for life.

Their tight orbits mean these planets often cross over each other when we look at the system. Nick Tusay at the Pennsylvania State University and his colleagues used this to look for radio signals that might leak in our direction when two of the planets talked to each other, supposing any intelligent alien civilisations were present.

In total, the team observed seven events in 2022, lasting 28 hours in total, using the Allen Telescope Array in California, which might have resulted in such a leakage (arXiv, doi.org/njsz). "Ultimately, we didn't detect any signals," says Tusay.

The team's search would have been sensitive to a radio signal at least as powerful as those transmitted by the Arecibo Observatory in Puerto Rico, which was the world's largest radio telescope before it collapsed in 2020. However, it is possible aliens could have been communicating using weaker instruments, or when the team wasn't looking, meaning that interplanetary communications in the TRAPPIST-1 system can't be completely ruled out. "Maybe we just didn't observe at the right time," says Tusay.

"It is possible aliens could have been communicating when the team wasn't looking"

Tusay says there are 60 to 70 other systems in our vicinity that could also be good targets for similar searches, but none quite as promising as this. "TRAPPIST-1 is just so good," he says. "Seven planets that are nearly perfectly aligned is very rare." ▮

Jonathan O'Callaghan

Chemistry

New chemical bond between atoms created

Karmela Padavic-Callaghan

IT IS rare for chemists to make a new kind of chemical bond, but they have just done it. A covalent bond that relies on a single electron has been created almost a century after it was first proposed.

All known covalent bonds, where atoms connect by sharing electrons, contain two, four, six or eight electrons, but in 1931, chemist Linus Pauling theorised a covalent bond with a single electron shared between two atoms. To finally create this, Takuya Shimajiri at the University of Tokyo, Japan, and his colleagues used a chemical reaction to remove an electron from an existing two-electron covalent bond between two carbon atoms. They used a large hydrocarbon that has very long bonds between its carbon atoms, which means it would be energetically costly for an electron from elsewhere in the molecule to replace the one they removed.

MARK GARLICK/SPL/ALAMY

A representation of the bonds that can form between carbon atoms

Shimajiri says past experiments that attempted such electron subtraction resulted in bonds that broke too quickly for definitive analysis. But his team's molecule remained stable long enough to analyse it. Based on how X-rays and several kinds of light bounced off or were absorbed, it was found to have a stable one-electron bond (*Nature*, doi.org/njsv).

"It's not often that you find a molecule with a new kind of bond," says Henry Rzepa at Imperial College London. This is a "major discovery" that could lead chemists to create whole new families of molecules, he says. ▮

Archaeology

Forests became less diverse when ancient people started herding pigs

Christa Lesté-Lasserre

ANCIENT DNA unearthed from a European rock shelter suggests that local herders tended goats and sheep more than 5000 years ago, but had switched to primarily pigs 2000 years later – right about when the surrounding forests became much less biodiverse.

The findings hint that keeping pigs – which root the ground and are less picky eaters than goats and sheep – might have played a role in how modern forests took shape.

Archaeologists already knew that people in central Europe started grazing animals in forests about 6000 years ago. Studies analysing pollen have shown that within the following two millennia, forests had shifted from being very diverse to having a low mix of plant species. While it has been suspected that this agricultural practice influenced the biodiversity loss, evidence for the idea was lacking.

Now, Matthew Walls at the University of Calgary in Canada and his colleagues have taken samples from up to 2.5 metres under the ground beneath a large rock overhang in a canyon in the mountainous Bohemian Forest, in the Czech Republic.

There is evidence the area sheltered animals and herders from wind, rain and sun over several millennia. Previous research teams have already extracted well-preserved fossils from the shelter's sediment layers, which represent the past 11,000 years. Walls and his colleagues analysed more than 400 million DNA sequences that they found in 10 layers of sediment. Some of the DNA came directly from plants and animals, and some from faeces.

1000 BC

By this time, forest diversity had dropped as pig herding increased

The researchers found that the deepest, oldest sediments contained no animal DNA. But starting 7000 years ago, they saw DNA from goats, says team member Giulia Zampirolo at the University of Copenhagen, Denmark. However, the quality of the DNA wasn't good enough to tell if they were wild or domesticated.

From 6000 years ago, DNA indicates that domesticated goats were in the area. Over time, sheep became more common, with cows sometimes accompanying them. Little by little, starting 4000 years ago, pigs also became part of the mix (*Current Biology*, doi.org/njn6).

By the late Bronze Age, 1000 years later, the most predominant domestic animal at the shelter was the pig. Although the DNA can't clearly distinguish domestic pigs from wild boar, since they were so closely related at the time, what matters is that the animals appeared to be herded in enclosed areas, says Zampirolo.

That timing corresponds with a shift in woody plant DNA, the researchers say. Starting about 4000 years ago, beech and spruce – which have less nutritional value for animals – became predominant. Two millennia before that, the forest was far more diverse and contained primarily hazel, maple and a little bit of elm.

"What we're able to see in this neat perspective from the DNA is that [previous research about biodiversity loss in early Bronze Age forests] coincides very clearly with this shift from sheep to pigs," says Walls.

Associating pig herding with the forest change makes sense, says Suzanne Pilaar Birch at the University of Georgia. "Pigs and boars are less selective in their feeding habits and can be quite destructive." The study adds to our understanding of how ancient humans changed the environment as they began practising agriculture, she adds. ▮

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The eating habits of domestic pigs, like wild ones, can be destructive

Space

Planet found in star's 'forbidden zone'

A distant planet should have been consumed when its star expanded to become a red giant

Jonathan O'Callaghan

A PLANET has been found orbiting a dead star in a zone where it should have been incinerated when the star died. The discovery might give us a window into the future of our solar system.

When stars like our sun exhaust their fuel, they first expand to become a red giant, then collapse into a dense, Earth-sized remnant called a white dwarf.

Using the James Webb Space Telescope (JWST), Mary Anne Limbach at the University of Michigan and her colleagues detected a spike in heat near a white dwarf called WD 0310-688, about 34 light years away from us.

That spike corresponds to a planet about three times the mass of Jupiter, orbiting its star at somewhere between 0.1 and two times the Earth-sun distance. The heat from this planet made the white dwarf appear about 21 per cent brighter due to a process called infrared excess, although this excess could also be explained by a disc of dust in the system.

Only a handful of planets have been found orbiting white dwarfs before, and none at this distance from their star. Some have been spotted in much tighter orbits. This can be explained by a planet migrating inwards after the red giant phase, perhaps being pulled by another planet or passing star. Others have been found in more distant orbits where they can survive the red giant phase without being incinerated.

But it is harder to explain how a planet could end up in what the team calls a "forbidden zone", where it should have been consumed by the expanding star (arXiv, doi.org/njpg). A possible explanation is that the planet is in the process of moving towards the star, says Limbach. If so, it would be a unique example of a white dwarf planet seen while migrating.

"It sort of breaks our basic understanding of where exoplanets should be," says Susan Mullally at the Space Telescope Science Institute in Maryland.

NASA/JPL-CALTECH

Illustration of a planet orbiting a white dwarf, the dim remnant of a star

In a separate study, Keming Zhang at the University of California, San Diego, and his colleagues found evidence of a planet orbiting at twice the Earth-sun distance around another white dwarf 3000 light years away.

The planet, roughly double the mass of Earth, was discovered through microlensing when the white dwarf passed in front of another star and the gravitational pull of the planet stretched the star's light (arXiv, doi.org/njph).

It might once have been in an orbit similar to Earth's before being pushed outwards during its star's red giant phase, which suggests there is a chance our planet could avoid plummeting into the sun in the distant future, says Zhang.

"There seem to be more planets closer to white dwarfs than we were expecting," says Limbach. "Maybe planets find their way in more often, and maybe that's something that will happen in our solar system too." ▮

New Scientist Live

What's the weather in space?

See Suzie Imber discuss how the sun's activity can drive auroras on 13 October newscientist.com/nslmag

Health

Placebo pain relief may not involve dopamine

THE hormone and neurotransmitter dopamine is generally believed to be a driving force behind the pain relief from the placebo effect, but it may actually play little or no part in the phenomenon.

The placebo effect occurs when someone's medical symptoms are lessened through the power of expectation, such as by taking a sugar pill. Dopamine, along with opioids and cannabinoids that are produced naturally in our bodies, was thought to be involved in the placebo effect for pain relief.

To get a clearer picture, Ulrike Bingel at University Hospital Essen in Germany and her colleagues asked 168 people, aged 18 to 40, to apply two creams to different parts of their arms before being touched with a heated rod, which caused mild discomfort. The creams were identical, but participants were told that one contained an active pain-relieving ingredient and the other was acting as a placebo.

Shortly before, the researchers asked the participants to take medications that suppressed dopamine, encouraged its release or didn't alter its level.

People's dopamine levels changed as expected, but this didn't seem to affect how much pain they felt or how much they anticipated that they would feel, which were both rated on a scale of 0 to 10 (*PLoS Biology*, doi.org/njpc).

This suggests dopamine isn't directly linked to the placebo effect for pain relief, says Bingel. Opioids and cannabinoids probably play a role, and hormones such as oxytocin and noradrenaline (norepinephrine) may also have an effect, she says.

"People's dopamine levels changed as expected, but this didn't seem to affect how much pain they felt"

However, it is possible dopamine comes into play when people are more motivated to feel pain relief, when pain is more intense, she says.

The placebo effect probably involves social factors that depend on the context around treatment, which are unlikely to be mediated by dopamine, says Lauren Atlas at the National Institutes of Health in Bethesda, Maryland. ▮

Christa Lesté-Lasserre

Views

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Comment

Mixed signals

Smartphones have indeed created an anxious generation, but it isn't young people, it is their parents, argues neuroscientist **Dean Burnett**

ELAINE KNOX

ACCORDING to Jonathan Haidt's bestselling book *The Anxious Generation*, the proliferation of smartphones and subsequent exposure to social media among children and young people has harmed mental well-being, resulting in an "anxious generation". Hence Haidt's title.

However, a closer look at the data reveals that such thinking is aimed in the wrong direction. The meaning and causes of increased rates of anxiety in young people remain complex and unclear. But simply put, when it comes to phones and modern tech, it is often parents who are the overly anxious ones, not their children.

So much of the current discourse about phones and young people stems from concerned parents, to the point where legislation is being introduced to quell their fears by restricting young people's access to the technology.

The problem is, even the most in-depth studies have yet to find any significant association between phone use and mental health issues in young people. And even when a link is identified, it is invariably a tiny one.

Ultimately, the amount of effort parents invest in reducing the dangers of smartphones for young people is out of proportion to the evidence that such "dangers" even exist in the first place.

Given that anxiety disorders can be described as "conditions that cause fear, dread and other symptoms that are out of proportion to the situation", it could well be argued that, rather than in teens, phones are causing excess anxiety in parents.

This manifests in other ways too. There is a belief that children should be encouraged to put their phones down and go outside more, because that is clearly the healthier thing to do. There are literal campaigns about this. But, yet again, this mindset doesn't fit with the actual evidence.

For one, the idea that young people can either use their phones or go outside is obviously flawed. No such dichotomy exists. Many people still refer to them as mobile phones! Portability is clearly a key feature of this technology.

But a deeper dive into the research shows a surprising trend. The time children spend outdoors, and the distances they wander from home, have been declining for decades, long before smartphones became ubiquitous.

There are many factors behind this, such as urban development of once-empty spaces, or how there are ever more cars on the roads, presenting a danger to an unsupervised, meandering child.

But one significant factor in this decline is changing parental attitudes. Parents have grown increasingly concerned for their children's safety over the decades, being ever more likely to restrict them from unsupervised free play outdoors as a result. While this may have been for valid reasons, restricting a child's freedom and movement leads to more health problems in the long term.

Ultimately, the anxieties of many modern parents regarding their children's safety directly harm their children's health. It is quite the conundrum.

This situation becomes even more surreal when you learn that this trend of increasingly keeping children indoors has gone into reverse in recent years. Why? The most obvious answer is phones! Children having their own phone means parents can check in on them at any time, meaning they are more willing to let young people out of their sight. So, isn't it irrational to then blame phones for children not going outside enough? Yes, it is.

And yet, as with many factors that affect the parent-teen dynamic, if there is a genuine problem regarding phone use (and this does happen), an open dialogue is the most helpful approach. It certainly beats trying to control a teenager's behaviour based on gut feelings, suspicions or anxieties.

Dean Burnett is author of *Why Your Parents Are Hung Up On Your Phone and What to Do About It*

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Not sure what to see at New Scientist Live?

Here's what members of the *New Scientist* team are most looking forward to

Martin Davies
Head of event production

New Scientist Live is just around the corner and the excitement in our office is now palpable. I'm counting down the days until we open the doors to ExCeL London and thousands of science enthusiasts come streaming in.

This year, the show will run from 12 to 14 October, with Monday 14 October just for schools. We've got some of the best-loved names in British science, from Alice Roberts to Adam Rutherford. You can explore the cosmos with Chris Lintott and discover why we die with Nobel prizewinner Venki Ramakrishnan.

If you can't make it in person, we will also be streaming every stage live for our online ticket holders. You can even buy an online upgrade if you're at the show so you can go online after the event to catch up on anything you missed at the time.

Our four main stages will cover the biggest questions in science. You can explore the secrets of the cosmos on the Universe Stage, the mysteries of being human on the Mind and Body Stage, the wonders of nature on the Our Planet Stage and the science of tomorrow on the Future Stage.

On top of this, there is the Engage Stage, which is our informal arena for interactive presentations. You can play genetics bingo, watch a recording of our hit podcast Dead Planets Society or debate the greatest science fiction novel of all time with our literary panel.

As always, our packed show-floor has amazing exhibits where you can get hands on with the latest science and innovations. From the hospital of the future to the Incredible Oceans experience, you're sure to find something to delight and amaze. Our dedicated day for schools on Monday 14 October will be packed with compelling, fun and thought-provoking talks, from the rudest bits of science to how to leave the planet. Check out our website if you want to bring your school along.

Whether you're a veteran of past shows or are joining us for the first time, you are welcome at the world's greatest festival of ideas and discovery. I can't wait to see you there.

Leah Crane
Senior reporter

This is my fifth New Scientist Live, and it has never been anything less than delightful. The thing I am most excited for is on Sunday, when US editor Chelsea Whyte and I are putting on a live episode of our podcast with *New Scientist*, Dead Planets Society.

It's a slightly unhinged podcast where we take wild hypotheticals about how to tinker with the cosmos and subject them to the scrutiny of actual science, with the help of a special guest who's an actual scientist. This year we're going to play an interactive game about wrecking the universe, and it promises to be extremely fun.

Aside from that, I'm excited to meet some robots and hear lots of talks outside of my usual bailiwick, from dinosaur behaviour to the evolution of free will.

Rowan Hooper
Podcast editor

Two in five of the world's plants are threatened with extinction, yet most people aren't aware of the problem due to what is sometimes called "plant blindness". Chris Thorogood, who is deputy director of the Oxford Botanic Garden, is on a mission to raise the profile of plants and restore our vision.

At New Scientist Live, I'm looking forward to hearing him describe an epic expedition to Indonesia to investigate one of the world's most extraordinary plants: Rafflesia, sometimes called the stinking corpse lily.

The plant produces the largest flower in the world (a metre across), which emits the scent of rotting meat. It has no roots or leaves, instead parasitising a host plant and flowering when it needs to reproduce. As Chris says, Rafflesia is a fraudster and a thief, and I can't wait to hear more about it.

Carissa Wong
Health reporter

I'm excited to hear Kimberley Wilson's talk on what to eat to boost our brain health, as well as Venki Ramakrishnan's insights on why we die.

After those, it'll be a tough choice between David Spiegelhalter on how uncertainty influences our lives or hearing Adam Rutherford speak about human origins and how science can be a weapon against racism.

I'm also looking forward to hosting the Mind and Body Stage on the Sunday, where Camilla Nord will talk about the science behind mental health and Robin Dunbar and his colleagues will discuss the psychology of group dynamics – human behaviour is always fascinating!

Tim Boddy
Picture editor

While officially a cat person, I've found myself terribly excited about Rachel Casey's talk on the important role that dogs play in our lives. I will offset this with a talk about all things human, with David Robson on the laws of social connection. David has been on a fantastic run of sensitive and moving writing for *New Scientist* about human relationships and the psychological barriers that affect our day-to-day.

I also cannot wait to see *New Scientist* staff members Bethan Ackerley and Alison Flood on a panel with our former editor Emily Wilson, debating "what is the greatest science fiction novel of all time?" on the always engaging Engage Stage. I'm expecting belly laughs, and for it to get seriously heated.

Away from talks and panels, I'm intrigued and mildly scared by the Incredible Oceans experience, where there is a promise to get up close and personal with the giants of the ocean.

Obomate Briggs
Trainee video producer

This year I'm looking forward to the talks on the Future Stage, particularly Christopher French's exploration of anomalistic psychology. It's a sub-discipline I hadn't heard about, but as an avid watcher of shows and films containing paranormal phenomena, I am fascinated by the idea that science can provide an explanation for seemingly supernatural events.

Christopher promises to reveal how psychological factors can influence our perception of extraordinary experiences, and it will be interesting to watch him dissect examples of spooky goings-on.

On the same stage is Anne Coxon's talk comparing and contrasting the media portrayal of forensic science with reality. Having been very close to becoming a forensic scientist because of the masterpiece that is *Silent Witness*, I am looking forward to finding out whether I will be disappointed or happy with my choice.

Matthew Sparkes
Technology reporter

I'm excited to catch Neil Lawrence's talk on the difference between human and machine intelligence, and how AI can be safely used in everyday life.

I speak to so many cutting-edge researchers about AI and hear wildly varying opinions about where the current boom in research will take us and what the risks and benefits are. I may not always be convinced by an opinion, but any time I hear an expert talk I come away with a greater understanding.

***New Scientist* has published a lot of stories about the harms that AI can do and the problems that need solving in the field, but Neil seems to have a more optimistic stance than some other experts. He believes that our fears of being replaced by AI might be misplaced, and he promises to talk more about that, which I hope will be as convincing as it would be comforting to hear.**

Find out more at newscientist.com/nsl2024

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Annalee Newitz is a science journalist and author. Their latest book is *Stories Are Weapons: Psychological warfare and the American mind.* They are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading
Model Machines: A history of the Asian as automaton, *a fascinating exploration of the Asian robot trope, by Long T. Bui.*

What I'm watching
Ramen Akaneko, *a delightful anime about cats who run a noodle shop in Japan.*

What I'm working on
Shipping free books to states in the US where they have been banned.

This column appears monthly. Up next week: Rowan Hooper

This changes everything

Sexy Asian lady robots? No thanks Techno-Orientalism is a strand of futurism that condemns and erases Asian cultural power. We need to fight back against it, says **Annalee Newitz**

WE HAVE all come across dystopian visions of a bad future, like Margaret Atwood's *The Handmaid's Tale*. Less familiar is the practice of bad futurism, often hidden inside seemingly compelling stories, which promises an absurd tomorrow based on foolhardy assumptions about the present. It was my pursuit of the latter that brought me to a packed convention hall at the World Science Fiction Convention in Glasgow, UK, in August to watch an all-star panel of authors and critics discussing "techno-Orientalism". As I discovered, however, this idea goes far beyond fiction; it has infected our political and economic plans for the future, too.

You may not know the term, but if you have watched the 1982 movie *Blade Runner* or the 2002 TV series *Firefly*, you have seen it in action. As critic Kelly Kanayama put it, techno-Orientalism is a collection of tropes that describe a "bad, Asian-influenced future with no Asians in it". In *Blade Runner*, an apocalyptically polluted Los Angeles is full of signs in Japanese, but features virtually no Japanese characters. In the dark future of the space opera *Firefly*, characters curse in Mandarin, but we never meet a Chinese person. These are just two of many sci-fi stories that exhibit techno-Orientalism, which condemns and erases Asian cultural power at the same time.

Mai-Anh Vu Peterson at Britain's East and South East Asian Network, an independent arts organisation, pointed out that another techno-Orientalist trick is to represent Asian people as robots – or, as Kanayama summed it up, "sexy Asian lady robots". Outside sci-fi, Asian people are depicted as robotic, willing to do any kind of labour obediently. The panellists agreed that this idea fits into the stereotype that they are technologically advanced but culturally backwards, needing "humanisation" by the West. Rho Chung, a critic and researcher at the University of Edinburgh, UK, drew a parallel between the fear of automation stealing jobs and the fear that Asian people will.

The term techno-Orientalism is a nod to Edward Said, whose 1978 book *Orientalism* laid bare the way Western nations have demonised and fetishised their Eastern neighbours. It came into widespread use in the 2010s, thanks in part to the influential anthology *Techno-Orientalism: Imagining Asia in speculative fiction, history and media*, edited by David S. Roh et. al., and has since become a handy epithet to describe futurism based on racism and prejudice rather than evidence-based speculation.

"In the dark future of the space opera *Firefly*, characters curse in Mandarin, but we never meet a Chinese person"

This isn't just a matter of sci-fi's plausibility: techno-Orientalist anxieties influence the real world too, especially when it comes to science and technology. That's because techno-Orientalism is a fantasy about how Asian nations will destroy the West using their superior tech.

In the US, this fantasy has made it harder for scientists to collaborate with Chinese colleagues across the Pacific, even leading to the arrests of US scientists accused of colluding with the Chinese government. It is arguably fuelling many US politicians' obsession with banning TikTok, created by ByteDance, a firm founded in China. Fear of an Asian-dominated future has inspired anti-immigration laws across Europe, steep tariffs on Chinese goods in the US, and violence aimed at Asian immigrants in the UK.

Bad futurism leads to bad decision-making, and that can slow or even stop valuable innovation. So what's the solution? During the panel in Glasgow, author Eliza Chan said it was partly a matter of telling stories that include actual Asian people and represent Asian cultures in respectful ways. Her fantasy novel *Fathomfolk* explores a world where figures from Chinese and British folklore deal with war, immigration and finding community at the bottom of the sea. Aliette De Bodard's *Universe of Xuya* series, meanwhile, is set in a distant future where Chinese and Vietnamese cultures have given rise to a spacefaring civilisation.

Still, fiction alone can't solve this problem. We need the US and China to renew their decades-long Science and Technology Agreement, which fosters collaboration between them on scientific endeavours. As of me writing this, the agreement has lapsed, though *Nature* reports that the two nations are still in talks. The European Commission needs to invite more Asian partners into the Horizon grant programme, a €53.5 billion fund for research into climate, health and more. And we need to see Western governments creating a safer environment for Asian immigrant workers and students.

Techno-Orientalism leads to fear of the future and of each other. If we want our civilisations to advance, it is time to throw the old tropes in the trash, reach beyond our borders and build something better. ▮

Down to Earth

Photographer **Andrew McConnell**
Publisher **GOST Books**

YOU could be forgiven for thinking that this dramatic image is a still from a forthcoming science fiction epic, but it is actually the work of photographer Andrew McConnell, part of his in-depth series *Some Worlds Have Two Suns* – and it is very much of this planet.

McConnell began documenting the movements of Russian Soyuz rockets in 2015. Every three months, a spacecraft takes off from Baikonur Cosmodrome, a spaceport in Kazakhstan, carrying three astronauts and cosmonauts on a 6-hour journey to the International Space Station. At roughly the same time, three space travellers come back to Earth, landing in the remote grasslands to Kazakhstan's north-east.

This remarkable photograph from 2017 shows Russian cosmonaut Fyodor Yurchikhin in front of the just-landed Soyuz MS spacecraft (US astronauts Peggy Whitson and Jack Fischer are still inside the vehicle).

McConnell says that "often at these landings, the helicopters would arrive first with all the engineers and support crew", making it challenging to photograph freely. With this shot, he was able to "get into position before the helicopters came and kicked up the sandstorm", and knew immediately it was a "special image... unlike any other landing I had seen". It felt, he says, "otherworldly".

Opening with Kulash Akhmetova's poem *Prayer* – "I saw sandstorms – they wiped out the steppe settlement / I saw rockets – like visions, they hovered above me," she writes, in part of it – *Some Worlds Have Two Suns* is out on 4 October.

Tim Boddy

Rewriting nature for our time

A new entry in the canon of white, middle-class English nature writers is welcome, says **James McConnachie**, but what about the flowering of other, more diverse voices?

LUZA STUDIOS/GETTY IMAGES

THE tradition of the English nature writer is long, proud and distinctly genteel. Its origins lie with the pioneering 18th-century curate Gilbert White, writing from his inherited family home in Selborne, Hampshire. He features in a fine new piece of nature writing, *England: A natural history* (Doubleday/Transworld) when the author observes that "the parson had the time to stand and stare".

That author, John Lewis-Stempel, also has the parson's luxury. A successful writer with a string of nature books behind him, he explores 12 English landscapes, from the Thames estuary to the Cornish coast via a beechwood in Buckinghamshire, a Yorkshire moor and a Norfolk broad.

There isn't much of a thesis: the title, "England", feels more like an envelope than an idea. He goes to a place, mostly rural, describes what he sees and uses that as a springboard to tell you stuff about nature. And he does it very well. The writing is full of acute observations and striking metaphors. A passing kingfisher leaves "an atomic particle of cobalt to die in the air behind it". A river smells "lustral, weedy, dog wet, vital. Hormonal."

His knowledge, though, is the really impressive thing. Lewis-Stempel knows beech trees are anemophilous (wind-pollinated) and that the lark's vocal organ, the syrinx, lacks a cartilage fold called a pessulus, so produces a vibrato. He separates the anadromous salmon (migrating from salt to fresh water to breed) from the catadromous eel (the opposite).

He is also well up on agri-science. He can pick apart the disadvantages, for wildlife, of a silage cut over haymaking, and confidently quarrel with journalist George Monbiot over the sources of the pollution of the river Wye. ("It's the phosphate," says Lewis-Stempel.) He even cites scientific papers, which is untypical of the Greater English Nature Writer.

All this combines with his seemingly encyclopaedic knowledge of every creature and wildflower in England – and an astonishing degree of luck and skill in spotting them. He sees otters, a seal, an Arctic char (in Lake Windermere), vole babies and adder's eggs – even a dormouse.

There are moments when this omniscience falters. It isn't exactly true that grass needs a minimum air temperature of 6°C to grow in the UK. It depends on the species, and the key factor is soil temperature. Watching his Shetland pony nibbling on a willow tree, Lewis-Stempel repeats the popular myth that the willow "contains aspirin", and claims that his animals are practising zoopharmacognosy (animal self-medication). While willows do contain the related molecule salicin, this isn't quite the same as acetylsalicylic acid, the active ingredient in aspirin. That said, salicin and other molecules in willow can produce slight analgesic effects, so OK, maybe the pony knows something after all.

But quibbling with a book so generous with information is too easy. A more serious complaint is that the encounters with nature documented are rather idealised. They are also solitary – the mess of human existence is mostly out of frame. Lewis-Stempel, in short, is one of those white, middle-class "lone enraptured males" evoked by poet Kathleen Jamie in a review of another title for the *London Review of Books*. He even mentions a waxed jacket, a Labrador (called Plum) and family who fought at Agincourt. There is also his column for *The Times* and his landholdings – the 40 acres in Herefordshire he has written about so brilliantly in the past, plus the farmhouse in France.

None of this matters a jot, except that it forms part of a package with a vision of England some will find comforting and others excluding – and which I found unoriginal. When he celebrates a particular kind of chocolate-box English village as "how you think of England", it assumes a lot about who you are.

Such objections aren't inverted

Start here...

A Flat Place
Noreen Masud
Penguin/Melville House

"A gannet flew alongside the ferry for a while, its head yellowed as though by accident: brushed with turmeric or aged like paper. It flew very straight and seriously... and I had a strong sense of it as a living thing, an animal, held aloft by its muscles: a thick, sweet potato double handful of bird, choosing to move through the air beside us."

Cairn
Kathleen Jamie
Sort of Books

"You're crossing a gapsite; the empty acres beside a dock – ropeworks? warehouse? – colonised by grasses, knapweed, even some pioneer birch... a woman's pushing her infant in a buggy; her black garments billow in the onshore breeze. You proceed... headed for the human-shaped hole wrenched in the wire fence, then a pavement, tarmacked and official."

snobbery. Thoughtful writers like Richard Smyth (a distinctly Northern, working-class voice whose favourite bird, splendidly, is the pigeon) have skilfully traced the links between conservation and conservatism, the wilderness ideal and colonialism, and the folk tendency and nativism. Lewis-Stempel doesn't confront uncomfortable thoughts. For him, "the countryside of England is the greatest work of art in the world".

It can look different to people whose ancestors didn't fight at Agincourt. Michael Malay has just won the prestigious Wainwright prize for nature writing for his *Late Light* (see box, below), describing his love for the English outdoors despite feeling "self-conscious, aware of my out-of-placeness" as an Indonesian-Australian immigrant. For a radically different view, there is Australian Richard Flanagan in his astoundingly original memoir, *Question 7* (Chatto & Windus/Knopf). He called the English countryside "a long-ago poisoned land, domesticated and dead, full of the sounds of diesel and the odour of chemicals" – a place local people, inexplicably, "nevertheless regarded as bucolic and Edenic". People like Lewis-Stempel.

To be fair, *England* is anything but ignorant of environmental problems. Lewis-Stempel has harsh words for agri-business and knows more than most about its unfriendly wildlife practices. After rhapsodising about swimming in the Wye as a child, he admits given today's pollution, he "would not go into long stetches of its flowing waters in chest-waders". And at a downbeat moment, he stares glumly out of the train at "spavined diesel-dosed bushes of buddleia. Creeping bramble, as bad as barbed wire. Not much to see." But then that's Urban England. Not the Countryside.

"In Lewis-Stempel's encounters with nature, the mess of human existence is mostly out of frame"

You don't have to look far for less comfortable perspectives. Publishers have fallen over themselves to find and promote a more diverse range of authors, and the result, in environmental, landscape and nature writing, has been an efflorescence.

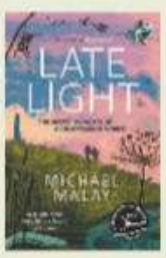
There are plenty such writers at work in the UK beyond Malay and Smyth. Try Jamie's new book, *Cairn* (see box), or her *Sightlines* (Sort of Books). There is also Jini Reddy, who explores belonging and otherness in *Wanderland* (Bloomsbury Wildlife) and *Wild Times* (Bradt Guides). Dara McAnulty, a neurodiverse young writer from Northern Ireland, is another Wainwright prizewinner. Or Noreen Masud (see box), whose haunting *A Flat Place* tackles English landscapes in the context of post-traumatic stress disorder and the legacy of a postcolonial age, melding memoir and nature writing in a startling way.

Internationally, cross-genre writing has proved fecund, often in the context of activism. There is Nemonte Nenquimo's *We Will Not Be Saved*, with Mitch Anderson (Wildfire/Abrams Books), about the Amazon. Robin Wall Kimmerer's 2013 book *Braiding Sweetgrass* (see box) is still a beacon for exploring scientific and Indigenous plant knowledge. And we must mention feminist-environmentalist Rebecca Solnit for her wonderful *A Field Guide to Getting Lost* (Canongate/Penguin Books) and *Orwell's Roses*, (Granta Books/Penguin Books), which explores the English relationship with nature.

Lewis-Stempel's *England* is richly informed and beautifully written. It is deeply rooted. Indigenous, even. But, sometimes, outsiders have more interesting things to say. ▮

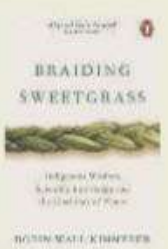
James McConnachie is a writer and editor based in Hampshire, UK

Late Light
Michael Malay
Manilla Press



"In England the hills would hold the light for hours, as though the sun had become mechanically stuck in its descent – no longer in view and yet close enough to light everything up: the valleys, the sky, the paths. I loved the light of those long evenings and the mood of those suspended hours; and I liked the experience of walking deep into blueness."

Braiding Sweetgrass
Robin Wall Kimmerer
Penguin/Milkweed Editions



"I wonder what it feels like to drag that tender skin – with a smooth, soft belly made for sliding over wet leaves – across the asphalt. I stoop to pick her up, circling my two fingers just behind her front legs. There is surprisingly little resistance. It's like picking up an over-ripe banana: my fingertips sink into her body, cold and soft and wet."

New Scientist *recommends*

Alex Wilkins
Reporter
London

My recent visit to Berlin for a planetary science conference coincided with Berlin Art Week. The exhibitions were mostly light years away from space and planets,

but, to my surprise, some were scientific.

Take Rohini Devasher's exhibition **Borrowed Light**, an intriguing exploration of astronomy. Its centrepiece, *One Hundred Thousand Suns* (pictured), was a four-screen video installation drawing on Devasher's time at Kodaikanal Solar Observatory in southern India. Interviews with the astronomers on the deep meaning they found in experiencing eclipses were particularly moving.

I also visited a photo exhibition called **Labor Lab**, by Sarah Ancelle Schönfeld. Her work focuses on the chemicals involved in being female, with psychedelic-tinged microscope images of hormones, such as progesterone or oestrogen, on prints hung around a white room (we had to don lab-like shoe covers). Faint, throbbing techno in the background completed this eerie experience.

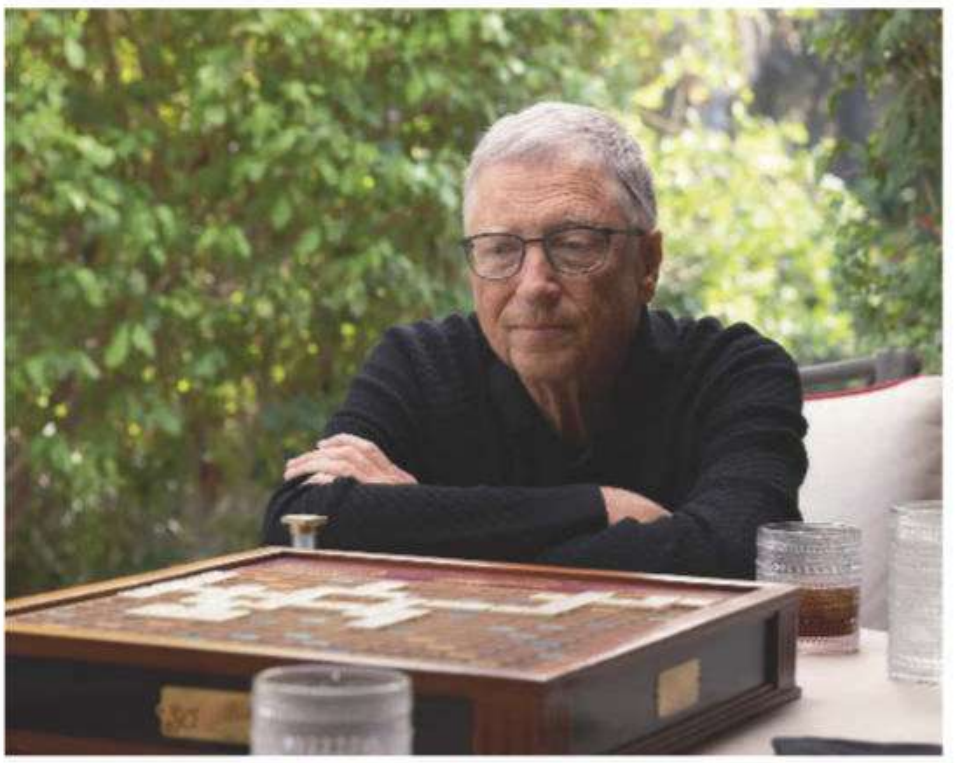
ROHINI DEVASHER

The TV column

Worlds apart

Bill Gates's Netflix series offers a bumpy ride as it discusses routes and roadblocks to the future – AI, climate, inequality, malaria and more. But Gates looms too large for alternative solutions to emerge, says **Bethan Ackerley**

Bethan Ackerley is a subeditor at *New Scientist*. She loves sci-fi, sitcoms and anything spooky. Follow her on X @inkerley



ROB LIGGINS/NETFLIX

Bill Gates thinks the ultra-rich should give away their wealth, as he does

WHEN you want to imagine the future, who do you turn to? Friends and family? Science fiction? *New Scientist?* Now you can check in with Bill Gates, as the Microsoft co-founder and multibillionaire has worked with Netflix on *What's Next? The future with Bill Gates*, in which he digs into make-or-break issues: artificial intelligence, misinformation, climate change, income inequality and disease.

The five-part series is uneven, though, and the worst instalment is perhaps the first, "What can AI do for us/to us". Gates is upfront about his role advising the leaders of OpenAI, whose ChatGPT transformed our understanding of generative technologies in 2022. But the documentary pretty much takes it as read that current AIs are miraculously competent – bar the odd bias and hallucination – and unstoppably marching towards superintelligence. Many would question that characterisation.

Little time is afforded to key questions such as the legalities of sometimes using copyrighted material to teach AIs and whether so-called transformer models like ChatGPT might soon hit a ceiling of usefulness. And what happens if AI-generated slop is fed back into training data? You won't find out from this series, which is weighed down by its attempts to present Gates as a leader in this field.

I would also advise skipping the fourth episode, "Can you be too rich?" Prepare to be shocked to learn that Gates believes the ultra-rich shouldn't be prevented from accumulating vast hoards, but should be more like him and give it away. We are told, constantly, that he has effectively imposed higher taxes on himself, as if this shouldn't be expected of someone in his position, and are presented with a mainly US-centric view of running an economy.

"When Gates covers topics like climate change and malaria, the series is better, enlightening even"

Systems must be tweaked to decrease the gap between rich and poor, we are also told. The alternative – restructuring beyond the business as usual that keeps millions in poverty and poisons the planet – would be almost inconceivable, the show implies. The most charitable reading of this approach I can stomach is that it is a spectacular failure of vision.

When Gates covers topics like climate change and malaria, the series is better, enlightening even. In "Can we stop global warming?", there is a detailed breakdown of the sectors of the economy most difficult to decarbonise. Gates invests in and is a customer of many companies offering technical solutions to some of climate change's stickiest issues.

A lot of the firms featured have also appeared in *New Scientist*, such as Climeworks, which is developing large direct-air-capture plants to suck carbon out of the atmosphere. It is refreshing that Gates, Climeworks and the film-makers all stress that such infrastructure is nowhere near the scale needed to solve the problem. Such sober analysis would have greatly benefited the whole series.

By the final episode, the focus is on malaria, Gates's real expertise. It is a thoughtful exploration of the tough ethical, ecological and social issues around developing vaccines and technologies such as gene drives, which could eliminate whole mosquito species.

But even this nuance is marred by the endless myth-making of Gates as god-emperor of all he surveys. He is undoubtedly an intelligent man with considerable achievements, just as *What's Next?* undoubtedly has a few big insights. However, it is hard to see other futures with Gates standing in the way. ▮

TV

What's Next? The future with Bill Gates

Netflix

Bethan also recommends...

Books

Non-Stop Inertia

Ivor Southwood

Zero Books

Modern life is characterised by restlessness – about work, housing, relationships. Southwood argues that this frenzy masks a paralysis of action and imagination.

Mutual Aid

Dean Spade

Verso

For an alternative view on how transformational change can be achieved, try this great primer on mutual aid, in which resources are shared within communities to provide unconditionally for those in need.

Editor's pick

Out of the corner of my eye I spied a monstrous thing

14 September, p 23

From Brian Darvell, Neston, Wiltshire, UK

Fear of snakes really is hardwired, as your look at our fascination with monsters highlights. At a social meeting, I had an involuntary startle reaction, thinking I had seen a python out of the corner of my eye – a friend was wearing brown trainers with a pale buff "eye stripe" either side. The feeling was strong and kept recurring that evening and on subsequent occasions, even though I knew what it was. I have no actual snake-related concerns and have had no bad experiences. I have never seen a python in the wild, but this was unshakeable.

From Guy Cox, Sydney, Australia

I and many others have argued that goblins, elves, pixies etc. are folk memories of other *Homo* or hominin species, which we know coexisted with our species.

Now, I am going to take this one stage further in relation to "monsters". The mass extinction at the end of the Cretaceous apparently wiped out 100 per cent of dinosaurs. I suggest that a few, scarce, surviving dinosaurs were around long enough after this to create the myth of dragons, found throughout Eurasia from Scandinavia to China. Of course, fire-breathing creatures are biologically impossible. However, on a cold morning, a warm-blooded reptile would have steam on its breath like a mammal, so it is easy to see how the legend could have arisen.

This new take on reality reminds me of something

7 September, p 32

From Dave Holtum, Bathampton, Somerset, UK

Thanks for the intriguing article, "Reality's comeback", which discussed Robert Spekkens's approach to reconciling the quantum and macroscopic worlds. His perspective seems to align closely with the principles of process physics, which posits a real world emerging from systems of interacting processes rather than the physical interactions of elementary particles.

This is rooted in the process philosophy of Alfred Whitehead, which has found widespread application in the social and biological sciences.

Plastics came from oil, they may go back to oil

7 September, p 17

From Christopher Jessop, Haverfordwest, Pembrokeshire, UK

Considering what a hotchpotch of substances are released from crude oil when it is "cooked" in a refinery, would it not be possible to use the vaporised plastic bottles and bags you describe as a refinery side-feed? Then, you could repurpose those molecules any way you wanted while using an existing process. Unless, that is, there is some problem with the chemistry of the plastics that would preclude this approach.

Could crowdfunding save threatened observatory?

24 August, p 20

From Milan Kralik Jr, Spinnerstown, Pennsylvania, US

Chanda Prescod-Weinstein's column made me think that if ever there were a project worth saving with a crowdfunding campaign, it would be the Chandra X-ray Observatory. There are millions of scientists, science students and astronomy aficionados around the world who would, I believe, contribute to this worthy cause to save it from the threat of cancellation. Surely NASA could find some protocol that allows it to accept a private donation?

Trolley problem has a rather selfless solution

31 August, p 28

From Terry Klumpp, Melbourne, Australia

There was a mention of the classic trolley problem in your look at a new book on morality. This left me wondering whether – rather than choose to push an innocent bystander into the path of the imaginary, out-of-control tram to save five people – you could, were you a paragon of virtue, instead throw yourself into the path of this runaway vehicle to use your own body as the trolley brake and save the five lives. But who among us would be so selfless?

One day a strange signal came from a distant star

Letters, 14 September

From Paul Whiteley, Bittaford, Devon, UK

John Hedger's letter on feeding coffee pulp to animals and the necessity of getting out in the field to find out why they weren't thriving made me chuckle.

In a similar vein, as a duty engineer many years ago, I was called into the control room of a large multinational telescope. The visiting scientists were getting some strange results from their spectrum of a star. They were excitedly talking about this and coming up with fantastic theories and solutions as to what might be happening inside the star or indeed whether they could trust the data. The spectrum did look weird. I went into the dome and found that someone had forgotten to turn the fluorescent lights out!

Astrology is bunk, but just maybe it did have a heyday

24 August, p 10

From Neil Wickens, Uraidla, South Australia

I have to agree that astrology can only be regarded as nonsense. How can the behaviour of any particular one-twelfth of the world's population be governed by the position of the stars at birth?

However, please consider the following: it is a fact that a mother's behaviour, living conditions, diet and so on can influence the development of the fetus during pregnancy. If we go back to when living conditions were seasonally dependent, then it is clear that a child conceived in, say, October in the northern hemisphere – where astrology developed – would gestate during a time of cooler weather, a lack of fresh fruit and vegetables, inhalation of smoke from open fires and so on, whereas a child conceived in, say, April would gestate during months with an abundance of healthy food.

This could lead to the children appearing to have characteristics depending on their date of birth and, hence, the position of the stars. There could be subtle variations spread over the year.

So, perhaps star signs weren't altogether nonsense at the time.

Try the zero-calorie gingerbread man diet

7 September, p 47

From Dan Salmons, Ilminster, Somerset, UK

Tom Gauld's delightful cartoon featuring gingerbread men raises an interesting possibility. If what one gingerbread man says is true, namely that you can "run, run as fast as you can! You can't catch me...", then the only conclusion is that gingerbread men are able to travel at the speed of light. From this, you can conclude that they must have no mass. So on this basis, they appear to be the perfect treat for those on a diet.

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed

Reimagining democracy

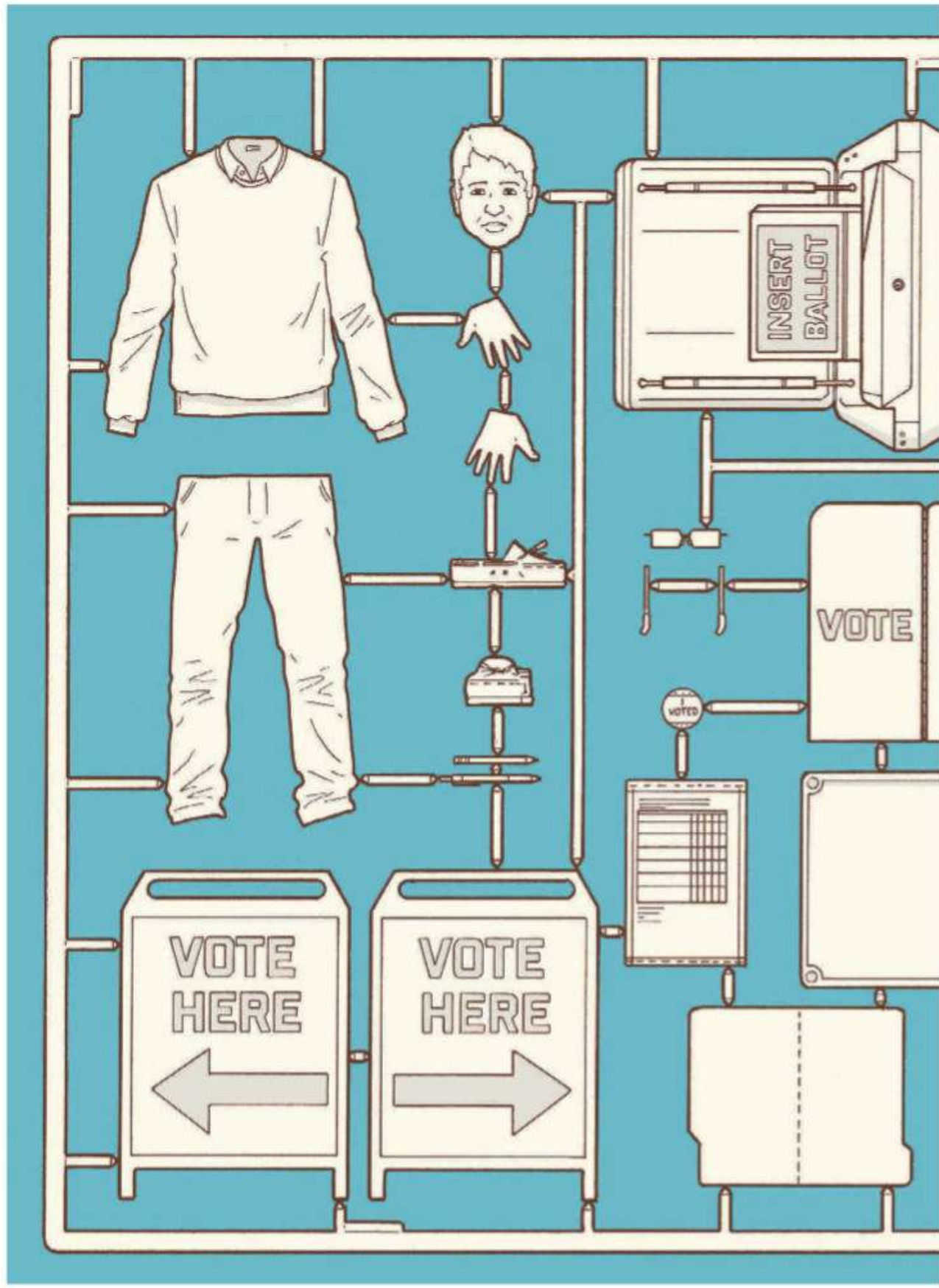
Can digital technologies help us rebuild a true government for the people, by the people? **Laura Spinney** investigates

MANY of us entered this so-called super-election year with a sense of foreboding. So far, not much has happened to allay those fears. Russia's war on Ukraine is exacerbating a perception that democracy is threatened in Europe and beyond. In the US, Donald Trump, a presidential candidate with self-professed autocratic tendencies, has faced two assassination attempts. And more broadly, people seem to be losing faith in politics. "Most people from a diverse array of countries around the world lack confidence in the performance of their political institutions," says a 2024 report by the International Institute for Democracy and Electoral Assistance.

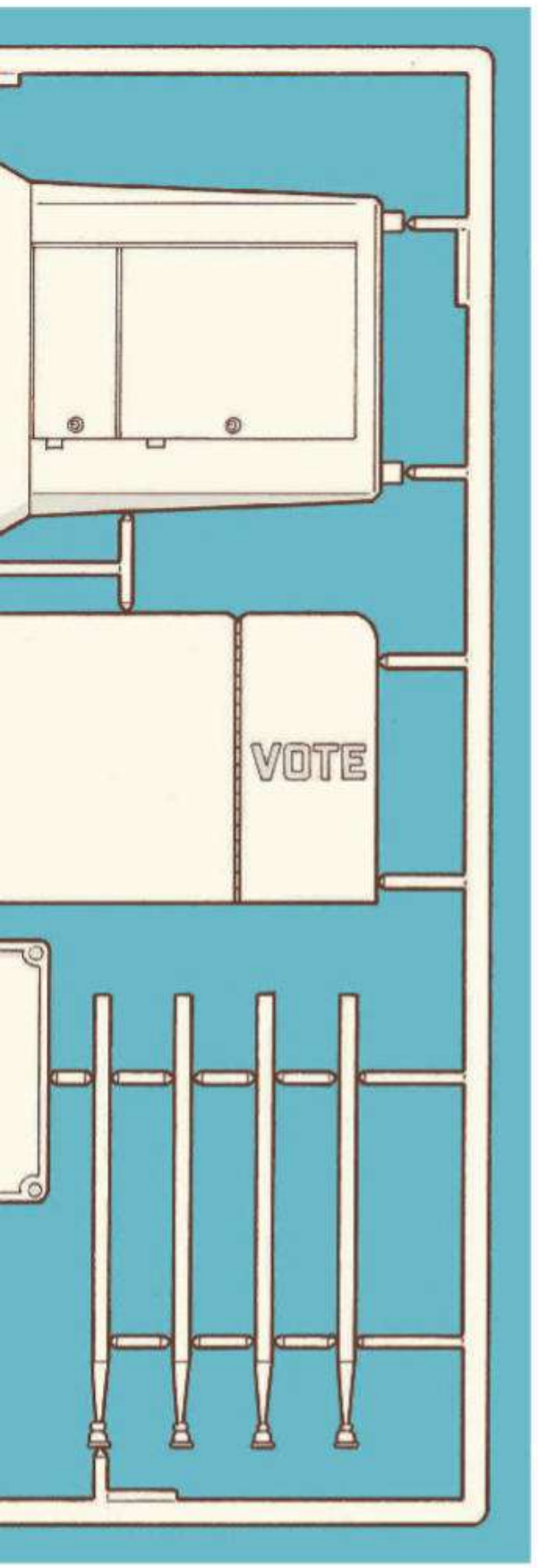
On many objective measures, too, democracy isn't functioning as it should. The systems we call democracies tend to favour the rich. Political violence is growing, as is legislative gridlock, and worldwide, elections are becoming less free and fair. Some 30 years after commentators crowed about the triumph of Western liberal democracy, their prediction seems further than ever from being realised. What happened?

According to Lex Paulson at the University Mohammed VI Polytechnic in Rabat, Morocco, we have lost sight of what democracy is. "We have made a terrible confusion between the system known as a republic – which relies on elections, parties and a permanent governing class – and the system known as a democracy, in which citizens directly participate in decisions and rotate power." The good news, he says, is that we can revive the original dream of government by the people for the people. That is what he and other researchers are trying to do. With insights from complexity theory, innovative online platforms and help from artificial intelligence, they are reimagining democracy for the 21st century by returning collective intelligence to the core of politics.

The word and concept of democracy dates from around 500 BC, when the people of Athens in ancient Greece devised a radical new system of government to harness collective



KYLE ELLINGSON



know-how to find the best solutions to their shared problems. In doing so, they grasped intuitively what a body of research now confirms: a cognitively diverse group produces better solutions than even the most brilliant individual. Admittedly, they left a lot of people out of their political problem-solving – notably women and enslaved people – but their system was far more inclusive than anything that had gone before, and it paid dividends. Among the city state's many achievements were important advances in astronomy, maths, literature and medicine.

A modern Athens

Today, most of us who think we are living in democracies are in fact living in systems closer to oligarchies, where the governing is done by small, usually wealthy elites. These elites are not only buffered from most people's problems, but from the problem-solving capacity of the crowd, too. The result is that many people feel they aren't being well served. In many places, there has been a populist backlash. But populism is even worse at solving our increasingly complex problems. "A lot of the problems we face as a species are the result of poor large-scale decision-making processes," says Mark Klein at the Massachusetts Institute of Technology.

Klein and Paulson are among a growing number of academics advocating a return to the Athenian model, scaled up for the modern world. For Paulson, who worked on campaigns for presidents Barack Obama of the US and Emmanuel Macron of France, the solution is three-pronged. First, revert to the Athenian practice of sortition or "lottocracy", where policy-makers are chosen by random, representative selection, as juries are in many countries. Second, capture as much collective intelligence as possible through AI-augmented deliberation. And third, reinstate civic education to produce citizens who are willing and useful participants of a true democracy.

Political scientists and tech experts have been discussing these ideas for 50 years, but only in the past decade have they begun talking to each other. And funding is now available to explore democratic innovation – for instance under the European Union's Horizon Europe programme and through a fund set up by OpenAI, the makers of ChatGPT. Momentum is building, says Paulson. The question is, can such innovations revamp democracy and restore stability in places where social crises and political violence are looming?

It is a big ask, because an electorate is a complex system that can behave in non-intuitive ways, becoming dysfunctional when pushed through so-called tipping points. "It's like freezing water," says Alexander Siegenfeld, a physicist at MIT. "If I keep lowering the temperature, nothing happens, nothing happens, and then I lower it a bit further and all of a sudden the water freezes."

Siegenfeld and his colleague Yaneer Bar-Yam at the New England Complex Systems Institute in Massachusetts used mathematical modelling to explore one such tipping point. Political polarisation waxes and wanes, but they found that when high polarisation combines with low voter turnout, the system becomes unstable, producing violent swings in outcomes. This is to do with people who have more extreme views being more likely to vote and politicians chasing these votes. As a result, the system produces governments and policies that most people don't want, frustrated voters then abstain and the instability is exacerbated. The US went through such a period in the 1970s, the researchers found, and elections have become increasingly unstable ever since – culminating in the 2020 presidential election and the political violence that followed. "This isn't just a patch of disturbance," says Bar Yam. "Exit requires change."

Siegenfeld and Bar-Yam believe replacing the first-past-the-post electoral system, which prevails in most US states, with ranked-choice voting and making voting compulsory ›

Disagreeing agreeably

In the Deliberatorium, an online collective intelligence tool developed by Mark Klein at the Massachusetts Institute of Technology and his colleagues, people are presented with a problem and asked to propose solutions. They can see all the proposals and then argue the pros and cons of each, the arguments appearing in a cloud around each potential solution; they can also add refinements, but they can't edit or delete another person's contribution. Participants go on to rate the arguments and, in a final step, collaboratively refine the preferred solution.

Say the problem is how to reduce greenhouse gas emissions. Someone might suggest a carbon tax, someone else a cap-and-trade system. But because a solution can generate further "sub"-problems (in the case of a carbon tax, for example, how high should the tax be?), what emerges is a topic-based "deliberation map" in which questions and answers are interleaved and each answer is surrounded by a cloud of arguments.

"Every distinct point appears just once, in a logical place, like in a library," says Klein. This makes it easy to find solutions, but also to spot gaps, including ideas that haven't received much discussion. A human moderator provides oversight for now, but an AI will eventually be used for much of the process. Bad solutions are quickly sidelined and people are encouraged to build on the thinking of others and aim for consensus, not just majority support.

"Many problems we face are the result of poor large-scale decision-making"

would help restore stability. Others, however, argue it would still fail to harness collective intelligence. Political scientist Hélène Landemore at Yale University is among them. She wants to see the return of sortition in the form of "open mini-publics" – effectively citizens' assemblies with randomly selected, demographically representative members. Although unlikely to be the shape of national governance anytime soon, in recent decades such assemblies have become more influential in Western countries. In Ireland, for instance, one contributed to the legalisation of abortion in 2018. And in France, Landemore guided another that culminated in the right-to-die bill now before parliament. "[Mini-publics] are showing us a way of doing politics differently," says Graham Smith at the University of Westminster, UK. He thinks they are better suited to solving 21st-century problems than the structures that govern us now.

But citizens' assemblies have drawbacks: they are vulnerable to influence from whoever sets the question being examined or hires experts to advise them, and can also be time-consuming. In the UK, a charity called Nesta is trying to minimise these problems in an ongoing experiment called the Strategy Room. Twelve people sit around a table and watch a factual presentation on the problem delivered via a tablet. Their initial views are polled, also by tablet, and the results kick off a facilitated discussion. They are polled again before leaving and in under 2 hours "we see a small but significant shift in people's preferences", says Kathy Peach, director of Nesta's Centre for Collective Intelligence Design. She says this indicates that people are thinking collaboratively and listening to each other. It also chimes with evidence that people reason most effectively through argument. Participants report enjoying the experience too.

However, this approach doesn't address perhaps the biggest problem with mini-publics: there are limits to how many people can take part before the debate quality suffers. Research suggests the optimal size of a discussion group is small – seven people or fewer. That is difficult to square with ensuring cognitive diversity. But the solution could be under our noses.

Large groups of people talk to each other all the time on social media. Far from halting the democratic backslide, however, this dialogue seems to be accelerating it. At present, online discussion platforms leave our collective intelligence almost untapped, says Klein. The essential problem, in his view, is that the conversation is structureless. "We've used internet technology to take regular, unstructured conversations and try to do them with hundreds of thousands of people, and it just doesn't scale," he says,

PAUL FAITH/AFP VIA GETTY IMAGES

FEDERICO PARRA/AFP VIA GETTY IMAGES

REUTERS/CARLOS GARCIA RAWLINS

A woman casts her vote in the presidential election in Venezuela (far left). A rally of the main opposition party in Taiwan (left).

resulting in a huge comment pile where ideas and voices get lost. People resort to unproductive strategies to get heard, including clique formation and attention wars, while others self-censor or drop out. The result is groupthink and toxicity – emergent dysfunction, once again. However, capturing collective intelligence online is possible, as Wikipedia's success shows. Despite being compiled by unpaid volunteers, it is as accurate as commercial encyclopaedias written by paid experts, and more frequently consulted.

The challenge is to improve online platforms and find ways of combining them with face-to-face discussion for a more representative debate. Klein and his colleagues have developed a tool called the Deliberatorium, which guides users through a process that is transparent and structured by topic (see "Disagreeing agreeably", page 34).

Celebrations in Dublin after a referendum in Ireland overturned the country's abortion ban, an outcome recommended by a citizen's assembly

Engineers are familiar with the concept of the Pareto front, the subset of all possible solutions that score optimally on multiple criteria. At the moment, we spend a lot of time far from that front. But the Deliberatorium is designed to get people closer to it – and it seems to work. In real-life situations where Klein has tested the tool – including at corporations Siemens and BP, and the Democratic party in Italy – several hundred people have found an optimal solution in as little as a day. "If the medium is the message, this is about changing the medium to change the message," he says.

Bring on the bots

Others are scaling up the debate in different ways. In Tilburg, the Netherlands, an OpenAI-funded consortium is using large language models (LLMs) – the technology that powers ChatGPT – to summarise small-group discussions in close to real time. The goal is to then share these AI-generated summaries between groups to "cross-pollinate" the debate among a larger number of people.

Meanwhile, another project at Delft University of Technology, also in the Netherlands, took the recommendations of a citizens' assembly on energy sustainability and presented them to a larger group of people via a digital platform. That larger group ranked them, explaining their arguments; this information was then fed on to a second citizens' assembly, which assimilated it before presenting adjusted recommendations to the municipal council – which approved them unanimously. Peach describes this approach as a "gold standard" and wants to see it adopted by the UK government. However, although local authorities have shown enthusiasm for the Strategy Room model, she has been told there is no money to roll it out nationally.

Perhaps it is unsurprising that governments don't tend to see democratic reform as a priority. "When you are struggling to pay for all your statutory responsibilities... public engagement falls to the bottom of the pile," says Peach. Arguably, though, governments are resisting their own salvation. For instance, since embracing mass participatory democracy just a decade ago, Taiwan, which many cite as a model, has seen dwindling polarisation and rising trust in government.

Change will also need support from citizens. This is where the third pillar of Paulson's solution, civic education, comes in. We need to relearn the value of collective intelligence. The Athenians learned democracy by doing it, and through such communal activities as civic festivals, sport and theatre, that helped them understand themselves as part of something bigger. In Taiwan, the recently overhauled curriculum emphasises co-creation and the common good from the age of 6.

But even the best deliberative technology won't get you far if people are resistant to new ideas and perspectives, says Simon Buckingham Shum at the University of Technology Sydney, in Australia. He spent years developing tools for online collaboration before turning his attention to education, and thinks what is required is a certain mindset. "The fancy words would be 'epistemic humility', which is to hold your beliefs lightly and to be ready and open [to other people's]," he says. He has built an LLM-powered chatbot called Qreframer that, rather than answer a student's question, challenges the assumptions underlying it.

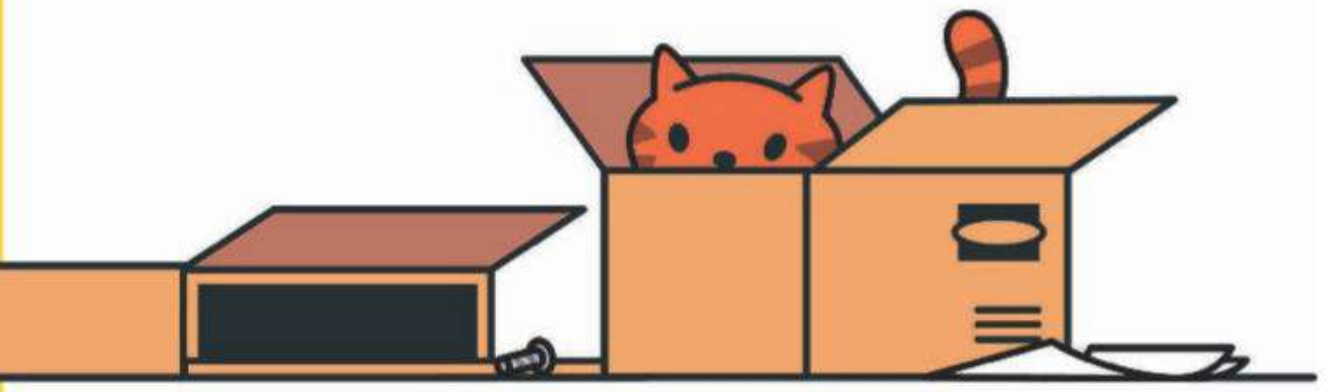
Political change requires bottom-up and top-down inputs, says Paulson – both a participatory movement and creative leadership. Once those are in place, it takes a spark – a *kairos* in ancient Greek, or "opportune moment" – to mobilise them. That could be an acute crisis to which government is perceived to have responded inadequately. Covid-19 didn't do it, and climate change is unfolding too slowly to qualify. If and when it does happen, however, there will at least be a blueprint for restoring an idea of demoracy that works for everyone. ▮

Laura Spinney is a writer based in Paris, France

EL DECORATE
ULYSSES
House Lovely
House Lovely
House Lovely
THE EASY PATH

The effort paradox

Understanding why we avoid effort, yet also seek it out, can help us commit to those hard but truly meaningful activities, finds **Amanda Ruggeri**



SPENCER WILSON

AS SOMEONE whose running shoes rarely leave the closet, I am both in awe of, and perplexed by, my endurance athlete friends. Particularly hard to grasp is that their love of running marathons or cycling up mountains isn't in spite of those efforts being so gruelling. They enjoy them precisely for that reason.

Humans, as a species, often think of ourselves as intrinsically lazy, even if scientists prefer terms like "effort averse". But we know that putting effort in can be deeply rewarding, to the extent that we may choose a more difficult process even if the outcome remains identical. We also seem to value effort after the fact, taking unreasonable pride in a poorly constructed piece of flat-pack furniture, say, because it was a struggle to assemble.

"On the one hand, effort is costly," says Michael Inzlicht, a psychologist at the University of Toronto, Canada. "On the other hand, it looks like we tend to value those things that we exerted effort for." In a seminal 2018 paper, he and his colleagues dubbed this apparent conflict the "effort paradox".

Since then, psychologists have been figuring out the origins of the effort paradox and why some of us struggle with tasks that others might find easy. What they are finding is offering fresh insights not only into how you can get off the couch and into your running shoes, but also how you can learn more effectively, better empathise with others and even cultivate a more meaningful life. "[It seems] that if we can become more effort-willing, we can learn to tolerate the aversiveness of effort," says Inzlicht.

For the past century, the "law of least effort" has held that humans, along with other animals, prefer to avoid exertion. Think of a sidewalk that is blocked. Do you take a shortcut around the barriers or follow a signposted detour? Most of us opt for the former. "We have very few laws in psychology," says cognitive psychologist Gesine Dreisbach at the University of Regensburg in Germany. "That one is pretty strong."

Researchers originally thought that our effort avoidance evolved to save metabolic resources, so we steered clear of hitting a physical limit. Over the tens of millennia when our ancestors relied on hunting and gathering, calorie intake was lower (and less predictable) than it is today. Wasting energy could mean life-ending folly.

But studies in recent decades haven't borne this out. "Our intuitions weren't quite right," says Amitai Shenhav, a neuroscientist at the University of California, Berkeley, and a co-author of the effort paradox paper.

Rather than feeling like something is effortful because we hit a physical limit, we may reach this point because we feel something is effortful. This is a phenomenon that psychologist Samuele Marcora at the University of Bologna, Italy, has demonstrated numerous times, finding that half-marathoners run more slowly and footballers cover less of the field if they are mentally fatigued, due to prolonged cognitive exertion, but not physically fatigued, for example.

The resource depletion idea hasn't held up very well in terms of explaining our tendency to avoid cognitive effort, either. While researchers have posited that we avoid mental effort because it uses blood sugar, this has been largely debunked; other metabolic arguments remain up for debate.

Along with Inzlicht, Shenhav is exploring a different explanation for why we find effort, including mental effort, off-putting: its emotional qualities. "One basic property of effortful tasks is that they lead you to think about what happens if you don't engage in effort – things like making an error, or disappointing people," he says.

And yet it is far too simple to say that the avoidance of exertion is the whole story. None of us would be on this planet at all had our ancestors not expended a great deal of physical effort to hunt, gather and survive. "People do not avoid effort in general," says Dreisbach. "They avoid the waste of effort." The complications come in the fact that how we each define the cost – or benefit – of effort differs depending on the task, the requirements and even our own abilities, personalities and resources.

Although this may seem intuitive, by thinking deeply about how and why we put more effort into some activities, researchers are beginning to unravel the effort paradox.

One clue comes from the observation that we seem to value effort after the fact – demonstrated by the so-called IKEA effect. Aside from those folks for whom a Sunday spent puzzle-piecing together flat-pack furniture is the highlight of the week, many of us would prefer that our bookshelf instead arrived premade.

If we choose to assemble it ourselves, we might think it is because the cost of that effort – including the time and the mental and physical exertion – is worth the money saved. But this doesn't entirely explain what happens after the process: once it is built, we often value that IKEA bookshelf more, ›

even preferring it to a better-made, less amateurish version. Our effort, in other words, doesn't just bring the benefit of reduced cost, it adds value in and of itself.

Inzlicht has found this in his research, too. In a paper he released in January, he and his colleagues asked participants, who were all undergraduate students, to write an opinion-based essay by themselves or using AI assistance. The students who wrote their own papers valued them as highly as the AI-written papers, even though the AI-written papers were rated objectively better.

The meaning of effort

This may be related to our sense of meaningfulness. In a related experiment, participants were asked to do a "Stroop task", which involves naming the colours of words. Inzlicht found that participants believed that the more effort a task required, the more meaningful it had been, regardless of what the task had (or hadn't) actually achieved. "The more effort they exert on that task, the more meaningful they say this truly meaningless task was," he says.

It isn't just our own efforts we value more highly, but other people's too. In one seminal study, participants gave higher ratings to a poem, a painting and a suit of armour if they thought the creations took more time to produce, even when told that all objects were created by skilled experts. The idea that the quality of an object is directly related to how much work has been put into producing it is known as the effort heuristic – and it is often true that more effort leads to a better result. Consequently, when we are faced with an outcome that we believe came from more effort, our brains take a cognitive shortcut to believing that this outcome is superior, whether or not it is.

Yet we might not just value effort, whether our own or other people's, retrospectively. We may also choose a certain, more arduous path because of its extra effort. In another recent study, Inzlicht and his colleagues ran 12 experiments that asked participants to do either a job that required some effort (like a Stroop task) or one that needed none (like watching a computer do this task). Most chose the effortful activities over the passive ones.

One reason for this, says Inzlicht, is that we tend to want to avoid a particularly unpopular emotion: boredom. "How can people 'always' prefer the less effortful thing, yet really dislike boredom? This suggests,

"If we learn to exert effort in one domain, it may expand our tolerance for trying hard in another"

Creating "desirable difficulties" can help students to learn

again, that our decisions about what to do and when to do it are not just solely based on whether something is more or less effortful. It's also that we want to be stimulated."

This isn't a uniquely human characteristic. Studies going back decades have found that, after prior conditioning, animals – including desert locusts, pigeons, starlings, gerbils, rats, macaques and chimpanzees – will choose to work for food, such as by pressing a lever, even when identical snacks are available in a nearby dish. But this is true only under certain conditions: as the animals successively get hungrier, or as the lever gets harder to press, there comes a point when they choose the "free" food instead.

Similarly, for many of us, something like building IKEA furniture probably needs to hit on the right effort balance, says Inzlicht. If the first step in the instruction manual sent us into the woods to chop down a tree, it is unlikely that many of us would view the process as being worth it.

This relates to the idea of a "flow state", which posits that there is a sweet spot when it comes to finding effort rewarding – any exertion should be just challenging enough to be stimulating, but not so much that it becomes frustrating.

That sweet spot, researchers say, will look different for everyone. Indeed, this variation between us may help explain the effort paradox in general, says Dreisbach. We tend to judge certain actions as being effortful for the person doing them, when this isn't actually the case, she says. "We think, 'Wow, are they especially motivated?' Probably not. They just don't mind. They don't experience the costs."

Appreciating exertion

The difference in how we each experience effort may even start in the brain. MRI scans, for instance, have revealed that although mental and physical efforts use different brain systems, one part of the brain – the basal ganglia – seems to be a shared centre that drives the motivation for both. Shenhav, meanwhile, co-authored a recent study in which participants decided how much cognitive and physical effort to put into a task involving foraging apples from a simulated orchard. While most preferred low-effort options, a consistent subset of participants – between 12.5 and 14.5 per cent – sought out both physical and cognitive effort.

Even if we all have different thresholds for how much effort we are willing to put in (or feel at all), research points to the idea that many of us would benefit from pushing ourselves a little more, if we did so strategically.

This is particularly well-documented when it comes to learning. In one oft-replicated type of experiment, for example, a group of students is asked to read a text, then to

RAWPIXEL LTD/ALAMY

read it again, before being tested. A second group reads the text just once, then is tested.

Which group do you think remembers the text better one week later? It is the group that read it just once. Making the finding more striking, immediately after the experiment, the twice-reading group performs better.

One hypothesis for why these gains reverse is that those who read the text just once feel less prepared for the test, so retrieving the information from memory creates what have been dubbed "desirable difficulties" by cognitive psychologist Robert Bjork at the University of California, Los Angeles.

"Many students think that if something feels hard, then that's not conducive to learning," says Anique de Bruin at Maastricht University in the Netherlands, who studies effort and learning. "For these specific learning strategies, it turns out that even though they feel more effortful, they're still helping your learning – and this is why they're helping your learning."

In educational settings, helping students want to put that extra, tactical effort in is often a matter of explaining "this paradox of perceived learning and actual learning", says de Bruin. "It's all about changing their views on this relation between effort and learning."

Many of us can identify an activity or task that we willingly choose to put effort into. For some, that might be running marathons or building bookshelves; for others, it might be working through a gruelling maths problem or finally finishing that copy of *Ulysses*. It can be easy to take these preferences on as an immutable part of our identities. Once a couch potato, always a couch potato.

Or are we? It turns out that if we learn to exert effort in one domain, it may expand our tolerance for trying hard in another. So, stick it out with *Ulysses* and you might just find yourself regularly lacing up your running shoes too.

As laid out by psychologist Robert Eisenberger in 1992, this is called learned industriousness: the idea that by positively reinforcing effort, rather than performance, you can encourage someone to work harder. And this benefit seemed to apply to brand-new challenges. For instance, Eisenberger's early work with Janet Mauriello Leonard at Siena College in New York found that, after being rewarded for completing mentally tough tasks, students tried harder and for longer on tasks that were completely unrelated.

Despite being a "brilliant" idea, however, "the empirical evidence was not complete", says Inzlicht. "Some of the ideas from that paper were never tested, or least never tested well." In research published in March, Inzlicht investigated Eisenberger's idea with more modern methods, using a series of challenging computer games in which players received rewards according to the amount of effort they put in. The concept of learned industriousness held up across the distinct types of game.

"If I reward your effort in one domain, it's possible that I will also increase your effort-willingness in a second domain," says Inzlicht.

Effort is costly yet we also seek out and value it

JULIAN FINNEY/GETTY IMAGES

He uses the example of teaching a child to play piano. If they learn to push through, despite not loving it, they may apply that same perseverance to, say, homework or sports.

Positive feedback

Indeed, this can be taught from an early age, backing up what lots of parents already know. "Many kids have, at a young age, this idea that if something's effortful, then it's probably not right," says de Bruin. "That's something that you can work on in terms of feedback – praising putting effort into something, instead of praising the outcome."

It is also important to teach children that if they do something for the first time, it is always going to feel effortful, she notes. However, this doesn't mean that they aren't good at it or should quit.

Beyond education, similar ideas can be applied to our relationships and how we treat each other. Empathy, for instance, can feel effortful and so be something we try to avoid feeling, as Inzlicht has found in previous experiments. "Cognitive costs deter people from sharing in experiences of others, a central but underappreciated point in the study of empathy," he and his co-authors wrote in a 2019 paper. If we recognise that empathy takes effort, and that effort itself can be a good thing, we may be more willing to work on being empathetic, Inzlicht suggests.

If more of us realise the implications of the effort paradox, researchers say, we can begin to reshape our relationship to effort, helping us change our habits and improve our well-being.

Exerting effort is connected to meaning and the concept of *eudaimonia*, a Greek word that roughly translates to human flourishing, says Inzlicht. It usually isn't when we do nothing that we feel our actions are meaningful and important, he points out, but when we are exerting some form of effort.

At the very least, this may mean we want to reframe how we think of our leisure time. Rather than sitting and passively watching television, we might want to pursue a hobby like crafting or puzzling, a physical activity like climbing or running, or solving a problem that is important for your family or community. "Our human limits are far vaster that we think," says Inzlicht, "but we stop ourselves." ▮

Amanda Ruggeri is an award-winning journalist based in Switzerland

"How did these black holes get so large so quickly?"

Recent discoveries have led to new questions about the origins of supermassive black holes. Astrophysicist **Sophie Koudmani** tells Daniel Cossins how sophisticated galaxy simulations can answer them

SUPERMASSIVE black holes are, as you might expect, rather large – millions and sometimes billions of times as massive as the sun. They lurk at the centre of all large galaxies, including our Milky Way, shaping the growth of these cosmic structures. And yet we can say precious little for certain about how they form and why they grow so big.

These mysteries have come into sharper focus in recent years thanks to the James Webb Space Telescope (JWST), which has peered back in deep time to spot a surprising abundance of supermassive black holes in the early universe. Intriguingly, it seems that just a few hundred million years after the big bang brought our universe into being, the cosmos already contained black holes that were far too hefty to make sense under our current models of how the cosmos evolved. There simply hadn't been enough time for anything that enormous to form.

Sophie Koudmani, an astrophysicist at the University of Cambridge, is among those trying to solve this conundrum. She uses supercomputer simulations to model galaxies and supermassive black holes in the early universe, testing ideas about their origins and growth and even predicting what we should be looking for in future observations.

BECKY GILL

Koudmani spoke to *New Scientist* about why supermassive black holes are so fascinating, the joy of discovering surprises in the early universe that throw up new questions, and how ambitious computer simulations can help us finally make sense of them.

Daniel Cossins: What is so interesting about supermassive black holes?

Sophie Koudmani: What I really like about astrophysics is that it brings together all the different disciplines of physics but under extreme conditions, and that is especially true of supermassive black holes. We're talking about extremely dense objects here, where a huge amount of mass – at least 100,000 times the mass of the sun – is concentrated in a relatively small space at the centre of every large galaxy. So there's an incredibly rich set of physics associated with supermassive black holes, which are really the engines of galaxies.

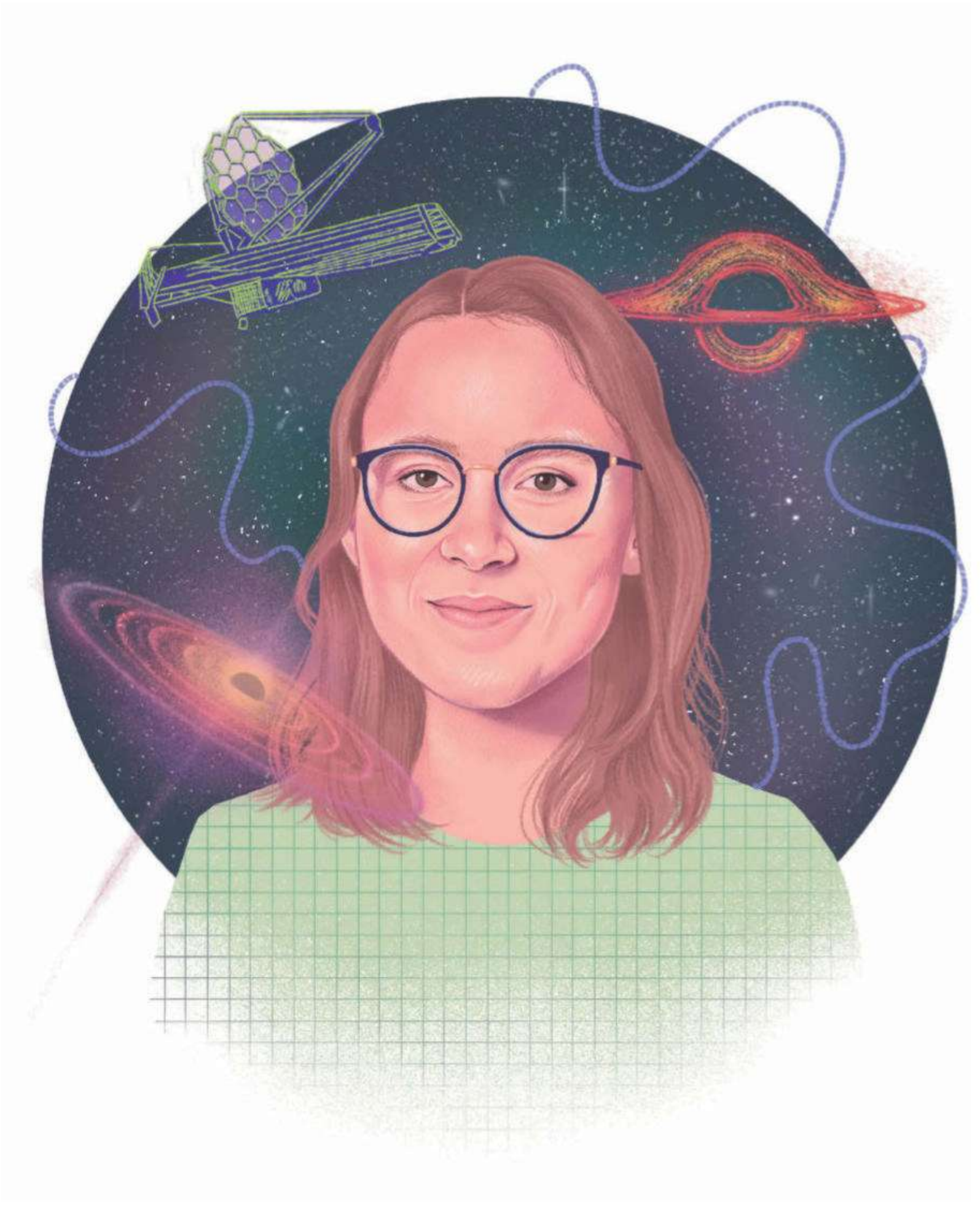
How exactly do supermassive black holes shape galaxies?

As gas spirals towards a supermassive black hole, it forms a flattened, disc-like structure called an accretion disc. The immense gravitational forces and friction cause the gas in the disc to heat up to millions of degrees, making it glow brightly – imagine the intense orange-white glow of molten metal, but far hotter and more luminous. But this energy doesn't just stay near the black hole. It is propelled outward in powerful jets and winds, travelling to the galaxy's outer edges.

Normally, stars form when galactic gas clumps together and collapses into dense spheres. But the fierce radiation and outflows from the supermassive black hole blow apart these gas clouds, preventing them from collapsing into stars. It is this interplay between the supermassive black hole and its host galaxy that drives the evolution of galaxies, shaping their gas structure and stellar populations. And this is something we see in simulations. The only way to get galaxies in the computer that look like the ones we can see is to include a supermassive black hole.

What are the big mysteries about these cosmic giants?

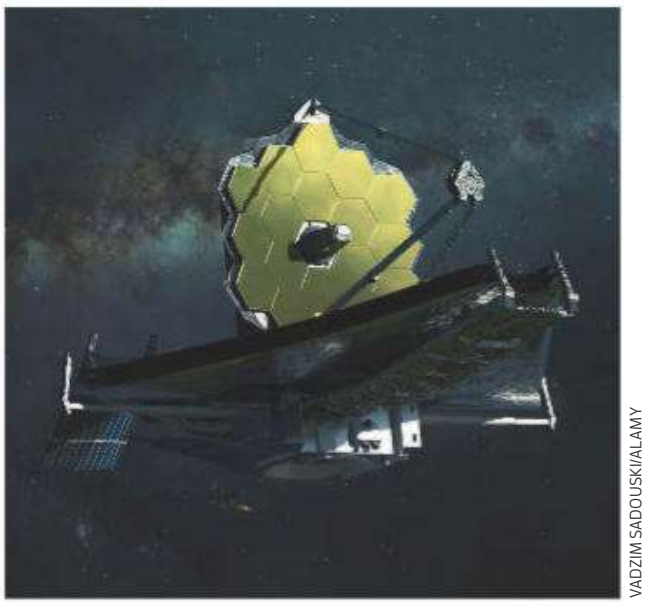
The two big questions are how they formed and how they became so big so quickly in the early universe. We can start with the second question, which has really come to the fore thanks to discoveries made by the James Webb Space Telescope. JWST has opened a whole new window into the early universe ›



in the past few years, because it is able to capture light from the very distant reaches of the observable universe, which has travelled to us from the very early universe. And we can now see supermassive black holes as they were when the universe was just 500 million years old – just a fraction of its current age.

The discovery that these early supermassive black holes can get so big so soon has been nothing short of mesmerising. It is an exciting moment because these early-universe supermassive black holes are appearing in much lower-mass galaxies than expected. What is particularly exciting is these discoveries open up a host of new questions. How did these black holes grow so large so quickly? What conditions could have led to their formation in such small, early galaxies?

The problem is that we would expect smaller black holes to be the seeds of supermassive black holes, but it's very, very difficult for them to grow so big in the timescales needed. So this really shows that we don't understand supermassive black hole growth very well: how the gas actually gets funnelled towards the centre and allows the black hole to grow so rapidly, especially in small galaxies.



VADZIM SADOUSKI/ALAMY

The James Webb Space Telescope has spotted several surprisingly large supermassive black holes in the early universe

You say that we expect smaller black holes to be the seeds for the creation of supermassive black holes, but is that the only way for them to form?
That remains a major open question, and we have several possibilities. Some people say that because we see these supermassive black holes so early on, they must have formed from the direct collapse of massive gas clouds, which would allow for them to start off quite massive.

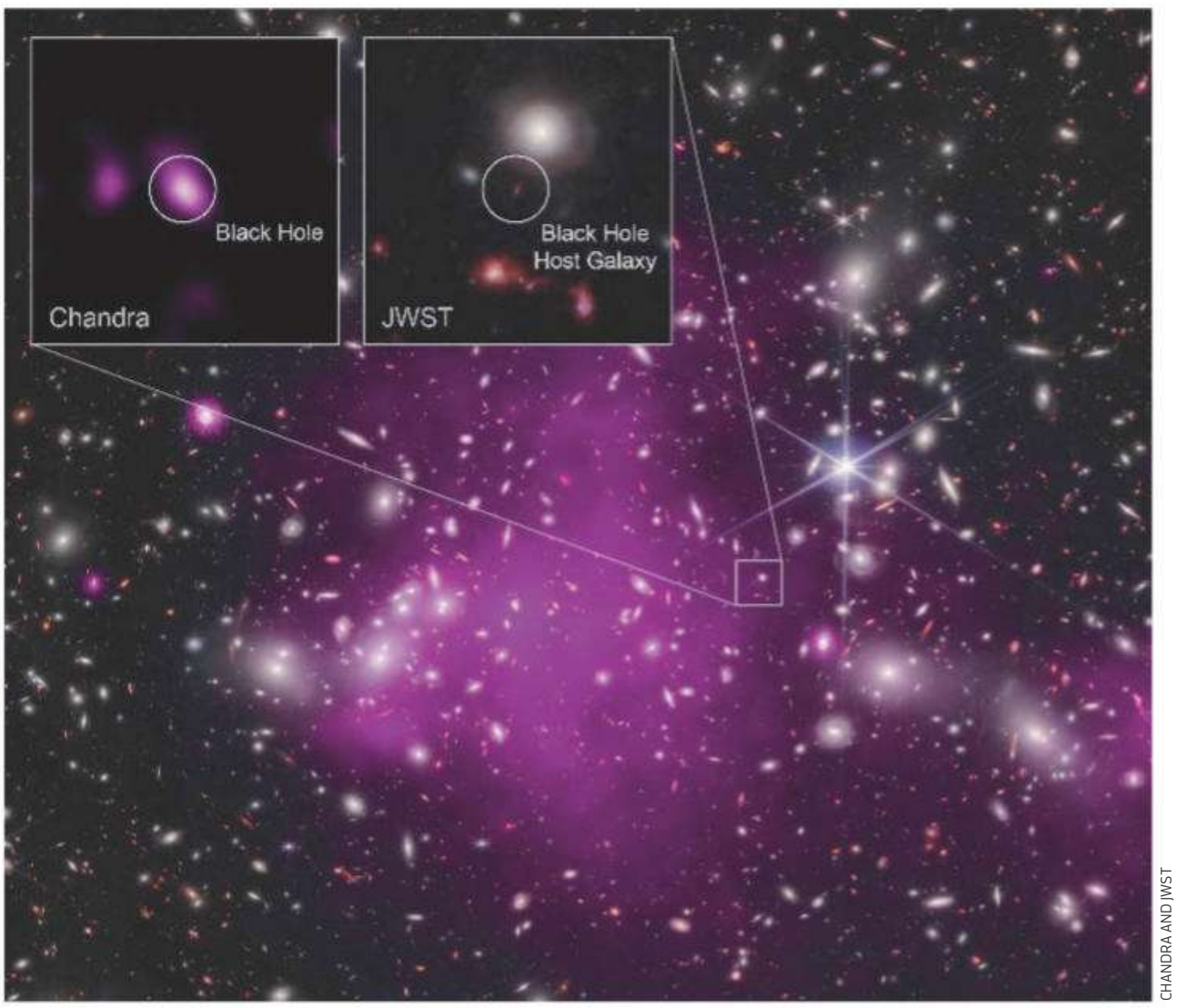
Others say you could start with a different formation channel that produces a lower-mass black hole that then grows very rapidly, even if we're not sure how. Here, the seed for the supermassive black hole could be the remnants of the first generation of stars, which were a lot more massive than today's stars and a lot more short-lived. Or it could be the extremely dense star clusters found at the cores of many galaxies, including our Milky Way, where runaway collisions create a supermassive star that collapses to become the seed of a supermassive black hole.

The ongoing controversy is whether the discovery of numerous large supermassive black holes in the early universe favours the heavy seed idea or whether there is still scope for light seeds, even though these would have had to grow extremely rapidly. The good thing is that these surprisingly large early black holes should help us to tease it all apart. It's an exciting time for us, because we have all these new questions and we are developing new simulations that we hope can tackle them.

Why are computer simulations so important?
If you have an observation of a galaxy, you only see a snapshot, whereas with computer models we can trace it from its birth to its present state. We get the full picture. Importantly, we can also use our simulations to test theories that cannot be tested with current observations and make predictions that we can then go out and test with future observations.

We have a few scenarios in mind for how supermassive black holes can form, and these will have different signatures in the early universe. For example, we can say that if supermassive black holes formed in a certain way, then an X-ray telescope would expect to see a certain thing. In astrophysics, it's very hard to do experiments because you can't rearrange the galaxies in the sky. But you can rearrange them in the computer and then see what impact different assumptions about supermassive black holes have.

How do these simulations work?
You can think of it like a galaxy in a box, where we can simulate the galaxy from its birth not



CHANDRA AND JWST

long after the big bang to the present day. You start with a few basic ingredients in the early universe – gas and dark matter and so on – and then you add hydrodynamics to model the gas evolution, and you have gravity. This is how you model basic structure formation, and then you plug in some assumptions about processes we are unsure about and run it forward.

Then there are processes that happen below the scale that you can see in the simulation, including most of black hole physics. That is what makes it so difficult, because the supermassive black holes are so tiny compared with the scale of the galaxy you are simulating. So you need to assume models for how supermassive black hole growth happens and then you feed that back onto the larger scales that it's impacting.

How can we use simulations to unravel the mysteries of supermassive black holes?

You can run lots of different models for how they form and how they grow in your simulations and compare the results to the data we have from JWST. So you can say, "OK, if this model is correct then we should see this in JWST data", or conversely you can say, "OK, JWST has seen this, what do we need to tweak in our models of supermassive black holes to replicate those observations in the results of our simulations".

There is one idea , for example, that says supermassive black holes actually form from the collapse of a very early, very massive star. This would probably be the formation channel that would form the lowest-mass supermassive black holes. In that case, you could use the simulation to try to see, given the observation constraints, whether it is at all possible to reach these black hole masses very, very early on. If so, when would the star have needed to form and then collapse? You can narrow it down more and more in your simulations until you can start ruling things out.

Given the amount that we don't know about supermassive black holes, how accurate can these simulations be?

Obviously, the computing capabilities have just reached incredible levels, so we can do much more accurate simulations and across many more scales than we ever could before. Some groups are now able to run hugely impressive simulations that span the scales from galaxies to the event horizon of a black hole, the boundary inside which gravity is so strong that light cannot escape.

Ultimately, we want to have simulations that encode all the information at every scale, from the cosmic web, which stretches across billions of light years, down to the event horizon. We want to feed the laws of physics in, along with our assumptions about supermassive black holes, and watch the entire universe evolve. That is beyond us at the moment, and that challenge is at the heart of my work.

How has the relationship between simulations and observations changed in recent years?

Simulations have gone from being tools we primarily use to interpret observations to being instrumental in making predictions that drive observational discoveries. It's a profound change and it's really pushing the boundaries of our understanding of galaxy formation and evolution, which remains one of these major unsolved challenges in astrophysics.

When JWST starts getting observations from even earlier times in the universe's history, we will be able to settle this question of how supermassive black holes form and grow in conjunction with simulations that predict the expected population at these times depending on different seeding models.

"Finding early supermassive black holes has been mesmerising"

The first direct image of a supermassive black hole, found in the galaxy Messier 87

EVENT HORIZON TELESCOPE COLLABORATION

These questions about supermassive black holes are clearly tough to answer. Why is it so important to get to the bottom of them?

I would say that everything in our universe is connected. The detail of the astrophysics of supermassive black holes and galaxy evolution obviously has an impact on cosmology, which seeks to explain the evolution of the universe as a whole.

Cosmology has now entered this high-precision era, where if we are to reconcile conflicting observations and stress test our best model of how the universe evolved, known as the standard model of cosmology, then we really do need to include supermassive black holes.

I really think that before we develop more exotic answers to some of these puzzles, as tempting as that may be, we need to fully understand galaxies and supermassive black holes. Without that, we cannot properly grasp how our universe has come to be what we see today. ▮

Daniel Cossins is head of features at *New Scientist*

Astronomers combined data from the James Webb Space Telescope and the Chandra X-ray Observatory to detect the glow of a supermassive black hole in galaxy UHZ1 just 470 million years after the big bang

NewScientistLive

Hear more from Sophie Koudmani at this year's New Scientist Live. On 12 October, she will discuss how supercomputer simulations help us solve the mystery of the origins of how supermassive black holes formed in the early universe.

For more information, visit newscientist.com/nslmag

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Dear David

Feeling zesty

Apathy can overcome many of us – even our advice columnist, **David Robson**. Here are some ways to regain your lust for life

David Robson is an award-winning science writer and author of *The Laws of Connection: 13 social strategies that will transform your life*

Resources

Everyday acts of kindness can be a great way to escape a rut. You can find a list of ideas that might inspire generous behaviour at randomactsofkindness.org/the-kindness-blog/2943-50-kindness-ideas-for-random-acts-of-kindness-day

Dear David, an evidence-based advice column, appears monthly. Drop David a line with your social dilemmas at davidrobson.me/contact. He will be talking about the laws of social connection at New Scientist Live on 13 October: newscientist.com/nslmag

Next week

Stargazing at home

MANY of us may face the odd day of apathy, but what should we do when those listless feelings linger for weeks on end?

This month, I was moved to hear from a reader who fears he has lost his "zest". "I would once wake up excited by the day ahead," he tells us. "Now I fail to engage with anything." It may feel hard to fight this emotional inertia, but the scientific literature offers some tips to nudge ourselves out of these ruts.

It is only recently that researchers started studying zest as a psychological construct. According to one measure, people are asked to rate – on a scale of 1 (not at all like me) to 5 (very much like me) – statements such as "I look forward to each new day" and "I want to fully participate in life, not just view it from the sidelines".

Losing one's zest is often a sign of depression – and if it coincides with other symptoms, such as altered sleep, disordered eating or suicidal ideation, it is vital to seek professional help.

It is perfectly possible to experience its absence without a clinical diagnosis, however. We may feel we are stagnating rather than flourishing – an unhappy state of being that deserves attention in its own right.

There are many possible causes for our ennui. According to research, we need a sense of "self-expansion" to remain happy in life. Once we become settled into adult life, many of us don't give ourselves enough

JONATHAN GOLDBERG/ALAMY

opportunities to seek novel experiences and learn new skills. Alternatively, we may find we have been placing too much importance on a single element of life, such as work, only to find that it can never offer the fulfilment we crave. (I have certainly been there.)

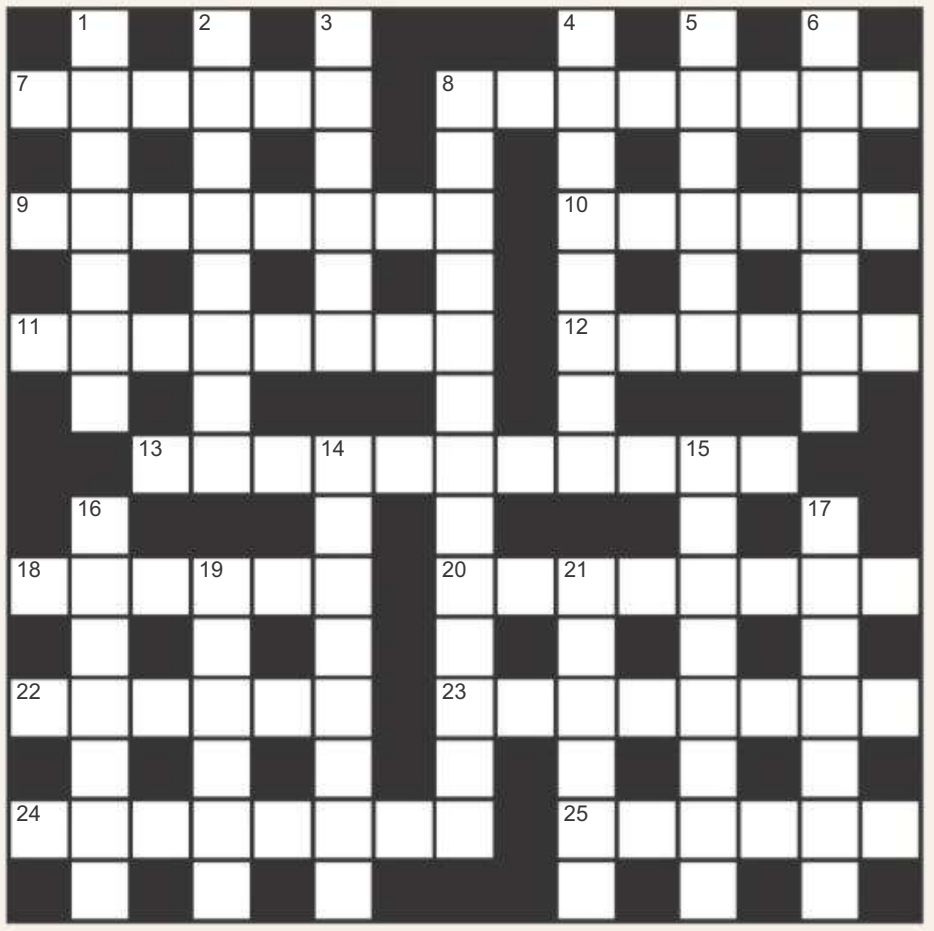
In either case, one potential means of restoring our verve is to explore an unfamiliar activity. This may be a different sport, a social commitment like volunteering (pictured) or an intellectual pursuit like stargazing. The important thing is to step outside our comfort zone and embrace the challenge of the new.

Alternatively, we may look to incorporate small well-being boosts into our day-to-day routines. This was the philosophy behind the Live More Project, a 10-week programme rolled out by Avondale University College in Cooranbong, Australia. The participants were given daily and weekly challenges, such as performing a random act of kindness, witnessing a sunrise, spending an evening by firelight or taking a digital sabbath. By the end of the programme, participants reported higher levels of flourishing, which included increases in engagement and optimism.

We can't expect instant miracles. Give ourselves time, however, and the weakest flicker of enthusiasm may transform into a new lust for life. ▮

These articles are posted each week at newscientist.com/maker

Quick crossword #168 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

7 New World stork (6)
8 Outside influence; trigger (8)
9 Swinging weight (8)
10 Ungulate toes (6)
11 Ascorbic acid (7,1)
12 19 Downs of energy (6)
13 Hexagonal structure of the compound C_6H_6 (7,4)
18 Increases the speed – of an engine, perhaps (4,2)
20 Last (8)
22 >90 degrees (6)
23 Sixth prime number (8)
24 ___ sign, hardening of certain lymph nodes (8)
25 Take away (6)

DOWN

1 Muscle weakness (7)
2 Psychological strategy (4,4)
3 Central parts (of atoms, perhaps) (6)
4 Nocturnal heathland bird (8)
5 Number puzzle popularised globally by Wayne Gould (6)
6 Less loud (7)
8 Silicon, for example (13)
14 Rigid airship (8)
15 Small worm (8)
16 Glenn ___, US chemist (7)
17 Demonstrate elasticity (7)
19 K, s or m, say (2,4)
21 Fractions of around 0.33 (6)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #272
set by Bethan Ackerley

1 What name is given to the narrowing of a bodily passage or orifice, e.g. the spinal canal?

2 In the history of spaceflight, the statement that NASA's flight control must be "tough and competent" is known as what?

3 Which of the following isn't a pterosaur: *Archaeopteryx lithographica*, *Quetzalcoatlus northropi* or *Dimorphodon macronyx*?

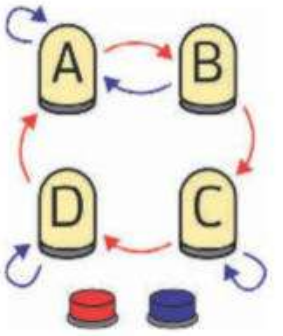
4 Which gas forms about 78 per cent of Earth's atmosphere?

5 What was the first cancer-causing virus to be identified?

Answers on page 47

BrainTwister
set by Paul Taylor
#40 There are four lights

A machine has four lights labelled A to D, one of which is lit at any time. It also has a red button and a blue button. Pressing a button changes which light is on according to the arrows shown. (An arrow from a letter to itself means the light doesn't change when that button is pressed.)



If light D is lit, how many different ways are there to press exactly three buttons and end up with A lit?

If the last button pressed was blue, what light cannot be lit?

If you can't see the lights, what sequence of three buttons could you press to guarantee that either A or D is lit?

What sequence of five button presses guarantees that light A is lit?

Solution next week

In a tin can

In a post-apocalyptic but non-nuclear world, how long would canned food remain edible?

Pat French
Longdon-upon-Tern, Shropshire, UK
It depends on the can, the food in question and the method of storage before, during and after the apocalypse. Reactions can occur between substances within the tin, whether that is between the food contents or with the tin's inner surface. Canned sardines in brine are more likely to degrade due to chemical reactions within the food than, say, canned peanut butter powder or sardines in oil.

Food cans are made of different alloys and other materials and have different internal coatings. The coating is often specific to the food contained and is sufficient for the intended shelf life with a good margin for safety. Famously, members of John Franklin's Arctic expedition in 1845 seem to have been seriously affected by lead poisoning from the solder in their unlined tins of provisions at a time when canning was poorly understood (see page 15 for new findings about the expedition).

The way in which cans are stored will affect the contents and the container. Mechanical damage

"Cans abandoned over a century ago by Ernest Shackleton have been tested by scientists and found to be safe to eat"

and temperature extremes will also exacerbate can failure and food deterioration.

Should an apocalypse typical of the Hollywood film industry ever happen, though, none of this will matter because all our surviving tinned food is likely to be consumed within the first year.

Mike Follows
Sutton Coldfield, West Midlands, UK
Scientists have tested food that was canned over a century ago, including cans abandoned by Antarctic explorer Ernest Shackleton. Although safe to eat, it had lost much of its flavour and nutritional value.

Canned low-acid foods like baked beans remain reliably edible for up to five years, while high-acid foods like fruit, tomatoes and pickles shouldn't be left in cans for longer than one-and-a-half years. Cool, dark and dry environments extend the shelf life of food, even when it is canned.

Damage to the can, like dents or rust, reduces the shelf life of the food inside. Indeed, such cans should be discarded as they can harbour botulism if the seal is compromised. Bacteria like *Clostridium botulinum* – the cause of botulism – don't produce an odour, so the smell of canned food shouldn't be used as a reliable guide that it is safe to eat.

Honey has an indefinite shelf life if properly sealed: 3000-year-old honey from the tomb of King Tutankhamun is still edible. Of course, we wouldn't be able to survive on honey alone.

Dehydrating, freeze-drying and vacuum sealing are other methods of extending the life of food. Freezing food depends on a power supply or living in a very cold place, which would introduce its own survival issues.

Many so-called preppers store food in a cool, dark and low-humidity environment. They label food and rotate their stocks so they always consume the oldest food first, before it exceeds its shelf life.

URBAZON/GETTY IMAGES

This week's new questions

Fast asleep **Why is it that people who snore loudly easily wake others, but rarely themselves?** ***Ben Walsh****, London, UK*

How brainy? **If human brains could be made larger, how much smarter could we become? And is there a practical limit to brain size?** ***Ray Carnally****, Christchurch, Dorset, UK*

Why does snoring tend not to wake the snorer, but is highly disturbing for their bedfellow?

Will Higgs
Gilsland, Northumberland, UK
While hiking in north-east Greenland in the 1980s, I came across tinned food left by prospectors searching for a site for a lead mine. The Blyklippen mine opened in 1956, so the food was presumably older than that.

We ate the contents of a few tins stored in a hut without ill effect. I also found a crate of tins of sweetened condensed milk lying out in the open. Their bottoms had rusted away, but I can assure you the stuff at the top was perfectly edible!

A different view

Do black holes look the same from any angle?

Ron Dippold
San Diego, California, US
In theory, yes; in practice, no. First let's distinguish the parts of a black hole. In the centre is the singularity, where all physics breaks down because the maths goes to infinity. The part we can "see" is the event horizon, where almost no light can escape the gravitational pull. We can't actually see it, because no light except faint Hawking radiation can escape to hit your retina, but we can tell where we stop seeing things – the central shadow.

Then there is the photon sphere, which is where light that comes in at just the right angle goes into tight orbit around the black hole. It eventually falls in or escapes, and we see the escaping light as a bright ring around the central shadow.

The biggest part of the black hole environment is the accretion disc, which is all the matter it has sucked up rotating in a giant disc around it. The extreme forces in this region cause the disc to glow. Some of the accretion disc is doomed to spiral in and be eaten, but some of it will be blown out in massive relativistic jets at the

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Tom Gauld
for New Scientist

SO, THE DIE IS CAST! BUT MARK MY WORDS: YOU SHALL RECALL THIS DAY WHEN MY GENIUS BLAZES ACROSS THE WORLD LIKE AN AWESOME COMET AND ALL COWER BEFORE THE STAGGERING REVELATIONS I HAVE WROUGHT!
YOU KNOW THEY GAVE YOU THE GRANT, RIGHT?
YEAH, BUT IT'S SO MUCH MORE FUN TO GIVE MY UNHINGED REVENGE SPEECH.

black hole's poles – these jets can approach light speed and be light years long!

So, the short answer is that the accretion disc and relativistic jets make a black hole look very different from different directions.

But what if we ignore them and just look at the event horizon? The (unproven) "no-hair theorem" posits that the only things you can measure about a black hole after it forms are its mass, its electric charge and its angular momentum, or spin. The mass and charge are the same from all directions, but the spin can be measured – it is what determines where the accretion disc is and which direction it rotates. If you somehow had a black hole with no spin, it would appear the same from all directions. But as soon as any matter falls in, it imparts spin, so it is very hard to have a black hole with zero spin.

What about a naked singularity, with no event horizon covering it? This continues to be a hot topic of debate. No naked singularity has ever been seen and anything dense enough to become a singularity would normally have an event horizon hiding it. But it is theorised that something spinning fast enough could shrink its event horizon to the point that the singularity was exposed.

"Kip Thorne made simulations of the optical effects for observers orbiting a black hole for the film *Interstellar*"

So practically, you can always tell where you are in relation to a wild black hole. But at some point, it might be possible to make a small, spin-less black hole in a lab that would be as symmetrical as your control over it allowed.

Nick Canning
Coleraine, County Londonderry, UK

First clarify what you mean by "the look" of a black hole. It isn't the same sort of thing as "the look" of Earth's globe seen from space. That involves light scattering off the planet's surface, but light can't scatter off the surface of a black hole's event horizon. The only optical clue to the presence of a black hole is its gravitational lensing effect on light from matter falling into the hole, heating up and emitting light while still outside the horizon, or light from background stars on the other side of the sky to the observer looking towards the hole.

According to theory, an event horizon's surface is perfectly uniform and smooth, so if the distribution of matter and stars is uniform in all directions outside the horizon, then the optical observations would be the same for all directions around the black hole. However, if the stars aren't uniformly placed, then visual observations will change as we orbit the hole.

Theoretical physicist Kip Thorne made simulations of the optical effects for observers orbiting a black hole for the film *Interstellar*. These agree with the later images of the supermassive black hole at the Milky Way's centre. ▮

Answers

Quick quiz #272 *Answers*

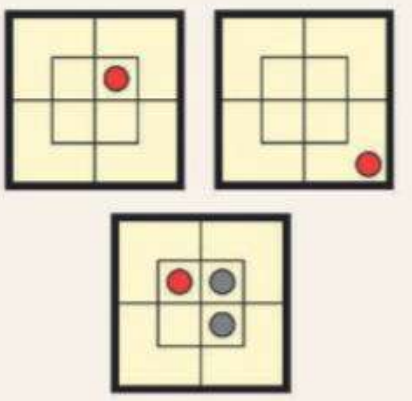
1 Stenosis
2 The Kranz dictum
3 *Archaeopteryx lithographica*
4 Nitrogen
5 Epstein-Barr virus

Cryptic crossword #145 *Answers*

ACROSS 1 Pirate, **4** Avatar, **9** Sputnik, **10** Mauve, **11** Album, **12** Methane, **13** Trouser suit, **18** Cadmium, **20** Ratel, **22** L-dopa, **23** Lab coat, **24** Deduct, **25** Astern

DOWN 1 Pascal, **2** Rhumb, **3** Tinamou, **5** Vomit, **6** Tsunami, **7** Riegel, **8** Skimmed milk, **14** Redwood, **15** Strobes, **16** Scaled, **17** Gluten, **19** Isaac, **21** Trope

#39 Game of logic *Solution*



A red counter in the top right interior section (first image) shows that some cakes are new and wholesome, but not nice.

Some old cakes that aren't nice or wholesome can be represented by a red counter in the bottom right exterior section (second image).

The red counter (last image) shows some cakes are wholesome, nice and new. The grey counters show no wholesome cakes are not nice.

Blushing chickens

People – humans – blush. Chickens aren't entirely inhuman in that they, too, show emotions on their facial skin. Delphine Soulet at the University of Tours, France, and colleagues have explored how skin redness might be a reliable indicator of "the affective states of hens". Reader Frédéric Darboux brought the project to Feedback's attention.

This is the story, to the extent it is a story, of six hens in a wooded outdoor range covered with grass. They had free access to a hen house and to as much water and feed as they wanted, whenever they wanted it.

This is a story, also, that was essentially a reality TV programme. The chickens were given no script to follow. But they were placed in situations that almost forced them to react in ways that would induce compelling video viewing.

The adventure stretched over three consecutive summer weeks. Among the main events: a "Capture Test" that involved "individual hens being caught by the experimenter, who restrained the wings with two hands". The hens also found themselves involved in a "Rewarding Test" that involved a glass dish containing mealworms and wood shavings "placed in the middle of the test arena".

The researchers captured video of "calm states": resting, preening or feeding. Other footage showed "exciting and rewarding states": dustbathing and exposure to mealworms. Inevitably, there were also "fear-related states", most notably seen in the Capture Test.

The colourful data came from a process of "extracting redness from still frames from hen profiles". In the old days, before digital technology was available for chicken-emotion research, this might have been a matter of subjective artistic appraisal. The 2020s method removes human emotion from that aspect of the data gathering. Electronic video processing extracted "the mean red (R), blue (B), and green (G) values for each bare skin region of the hen face (comb, cheek, ear lobe and wattle)".

After analysing the data from the videos, the scientists reached a conclusion as to when the chickens had blushed most strongly. The hens, says the final report, "exhibited the highest degree of facial skin redness in negative situations of high arousal".

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Eclectically smectic

If, somehow, your interests are eclectic and you are cathectic (but not apoplectic) about exploring words that rhyme with dialectic, try "smectic" – as in the title of the study "Smectic and soap bubble optofluidic lasers".

Written by Zala Korenjak and Matjaž Humar in a journal with the intriguing name *Physical Review X*, that paper explains how it doesn't take much to make a soap bubble become a laser.

Or, for a mildly jolly burst of melancholy, reach back to 1987 for P. Oswald's treatise in *Journal de Physique*, "Dynamics of collapse of a smectic bubble".

Tending towards entropy

Physics often gets portrayed as a field so abstruse that most people can't understand or directly use it. A new study called "The principle of entropy increase: A novel view of how tourism influences human health" shows how wrong some people feel that notion might be.

The researchers write: "The principle of 'entropy increase' is a universal law describing a natural progression from order to disorder. This paper is innovatively the first to take the principle as a theoretical basis for assessing how tourism influences human health from a sociomateriality perspective".

Back in 2000, a collaboration between physicists in Italy, Brazil and the US tried to make sense of a different and borderline-unruly aspect of the concept of entropy increase. They published a paper called "The rate of entropy increase at the edge of chaos".

Tourism professionals both do and don't like tourism to happen at the edge of chaos: they do for the excitement, but don't for the danger, the danger being both corporeal and financial. Too much entropy over too short a period could intensify both kinds of danger.

A press release about the new tourism research does note that "Entropy is classified as the general trend of the universe towards death and disorder". But other than that, the press release accentuates the positive. It says: "For the first time, an interdisciplinary study has applied the theory of entropy to tourism, finding that travel could have positive health benefits, including slowing down the signs of ageing."

In theory – in this theory – people might believe that principles of physics, adroitly deployed, can help a person delay seeing wrinkles. Raise this to a literary plane, Feedback muses, and it becomes a reminder to read Madeleine L'Engle's sci-fi novel *A Wrinkle in Time*.

That book's plot involves travel. That book's publication was reputedly delayed by publishers' indecision as to whether the story was meant for adults or children.

Pointy reckoning

A couple more additions to Feedback's collection of conversation-starting titles of research papers.

"Sword swallowing and its side effects" gave incisive knowledge to subscribers of *BMJ* in 2006, while "Estimation of the total saliva volume produced per day in five-year-old children" supplied some fast and, in some respects, hard numbers to readers of the *Archives of Oral Biology* in 1995. ▮

Marc Abrahams

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1 Over the ten years to 31 July 2024, the US dollar NAV per share compound annual growth rate ("CAGR") was 13% and the public market comparator (the FTSE All-World Total Return Index) CAGR was 9%.

2 Please also note the "NAV per share" percentages in the table above reflect the US dollar monthly estimated NAV per share.

3 HVPE introduced an additional US dollar share price on 10 December 2018; from this date onwards, the actual US dollar share price, as reported by the London Stock Exhange, has been used. Prior to this date, the US dollar share price had been converted from the sterling share price at the prevailing exchange rate. The share price total return figures have been adjusted for the redemptions which occurred in October 2013 and October 2014.